Aura Validation: H_2O Subgroup Session, Wednesday afternoon

1:30p Introduction

TES Comparisons
1:35p Annemarie Eldering
1:50p Bob Herman

MLS comparisons: Remote sounders and satellites
2:05p Gerald Nedoluha
2:20p Karen Rosenlof (for Geoff Toon & Ken Jucks)
2:30p Carlos Jimenez
2:45p Steve Massie (for Andrew Gettelman)
2:55p Thierry Leblanc

3:15p Break (15 minutes)

MLS comparisons: *In situ* measurements
3:30p Holger Vömel
3:50p Elliot Weinstock
4:00p Masato Shiotani
4:15p Bill Read

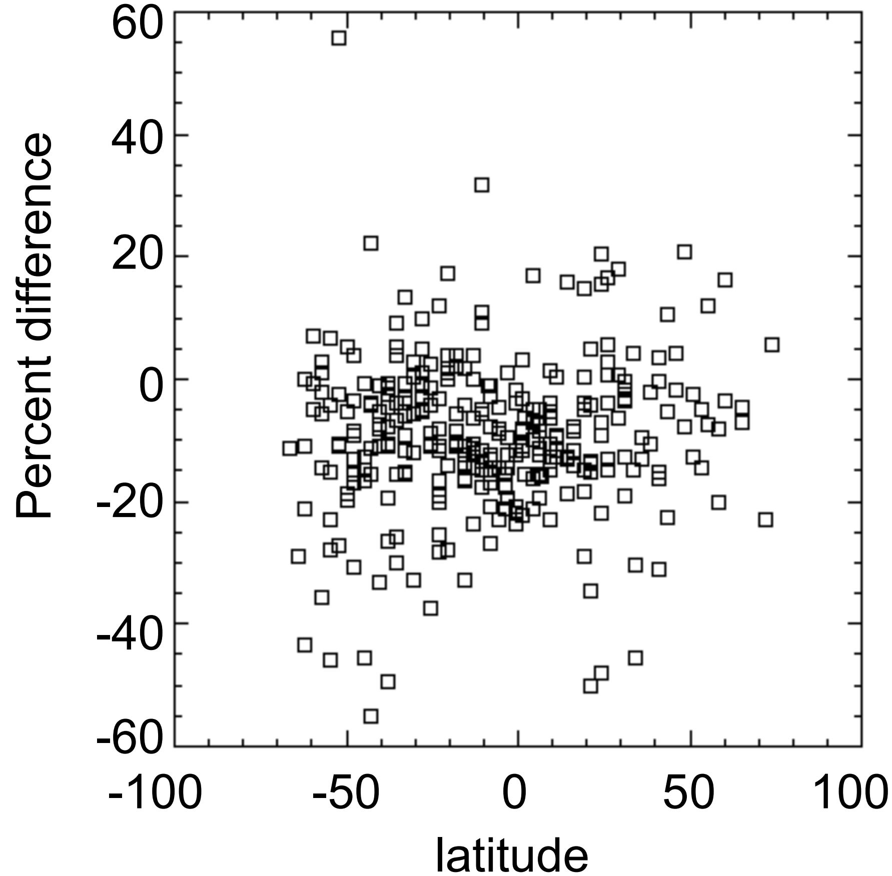
4:35p Open discussion

5:00p Adjourn for the day

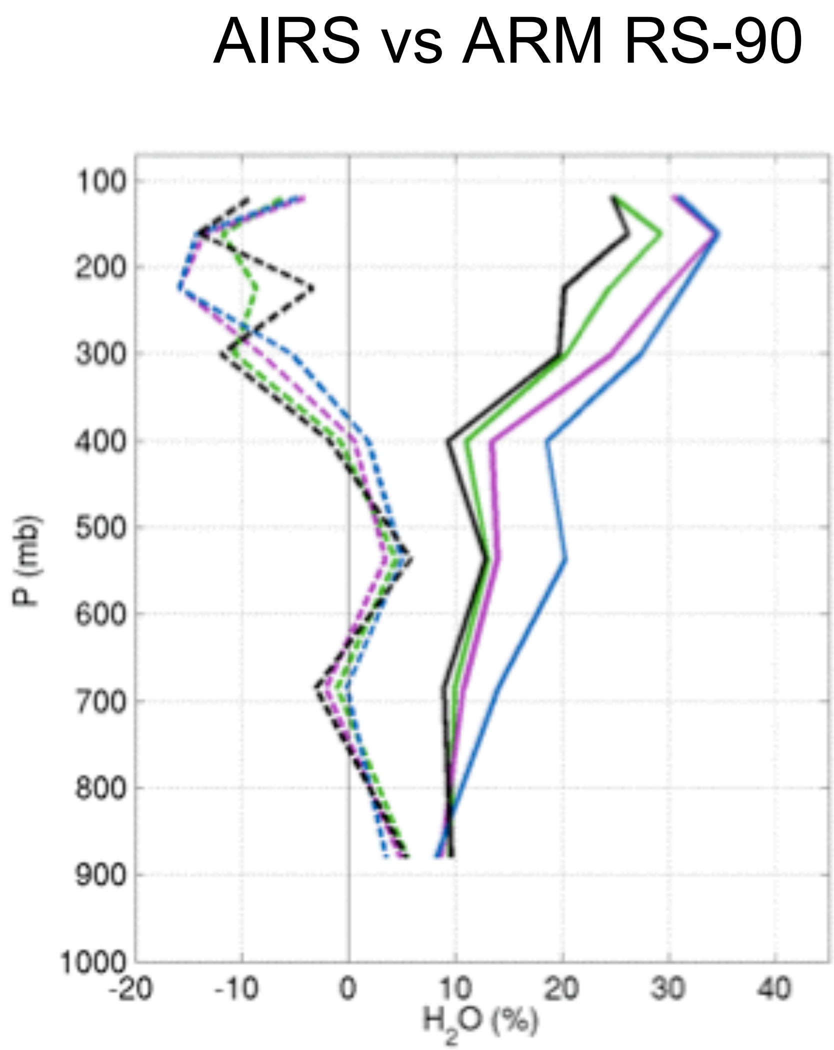
TES comparisons

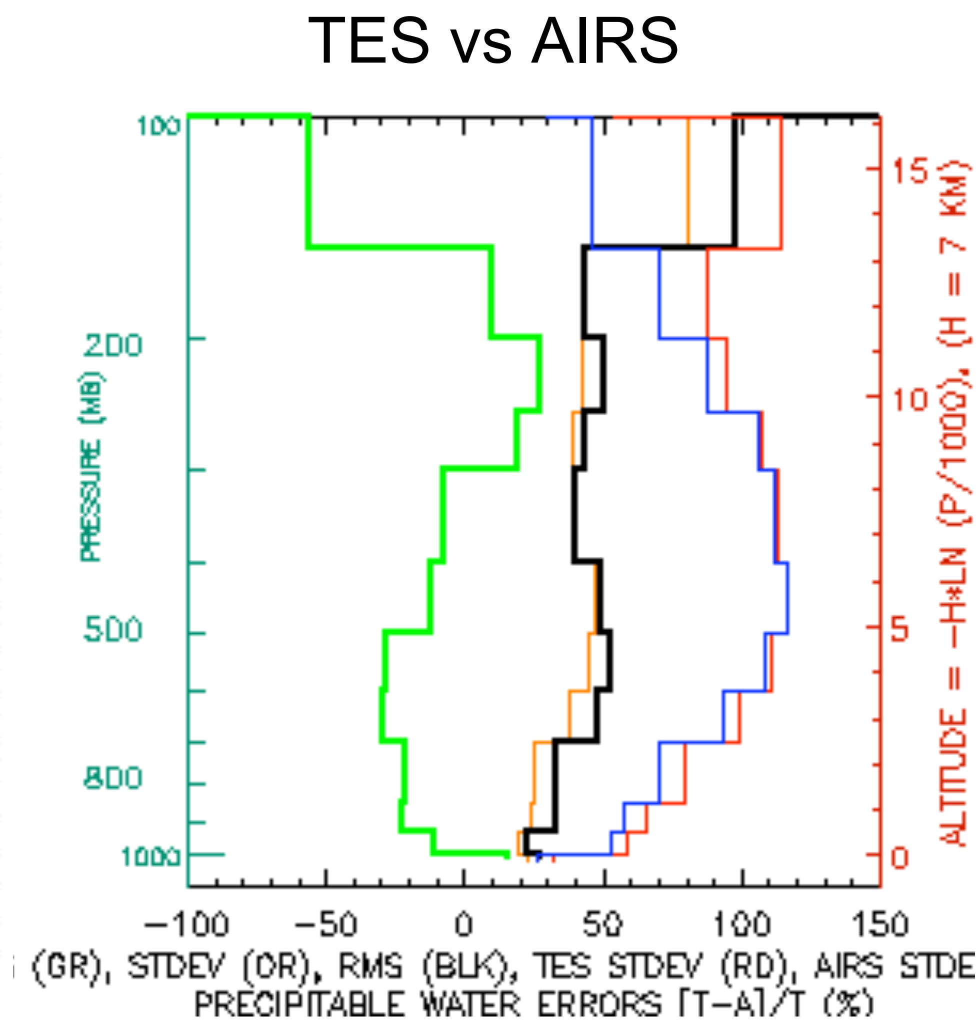
- with AMSR-E, AIRS & MLS
  - water column (AMSR-E)
  - profiles (AIRS & MLS)
    - some leveraging off of AIRS-ARM site sonde comparisons
- with aircraft and Vaisala RS-80 sondes

TES-AMSR-E difference
~10% TES dry bias



A. Eldering





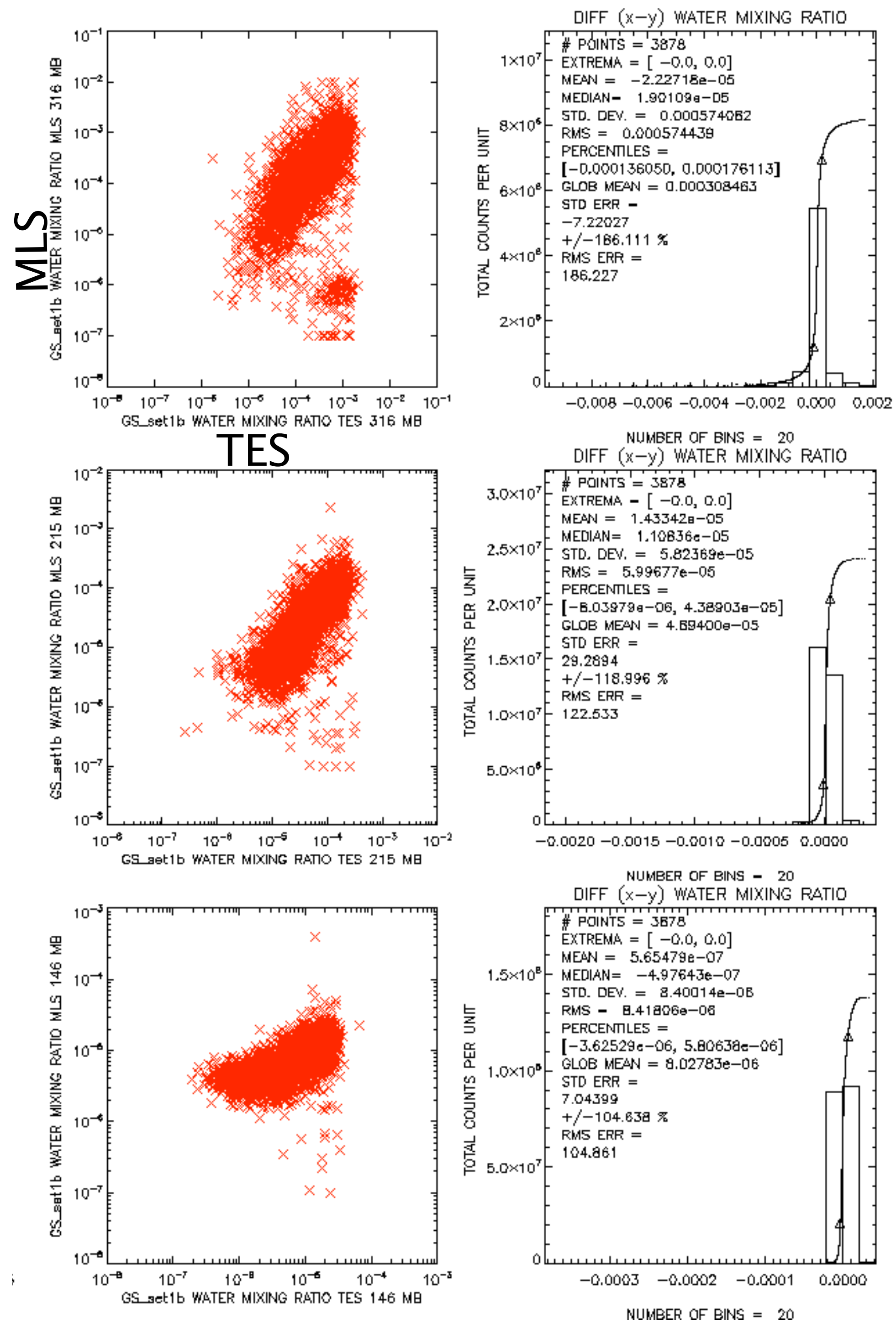
Bias in green ([TES-AIRS]/TES), rms differences in black

Also noted little latitudinal dependence in the TES/AIRS differences, and no dependence on cloud optical depth or fraction

A. Eldering

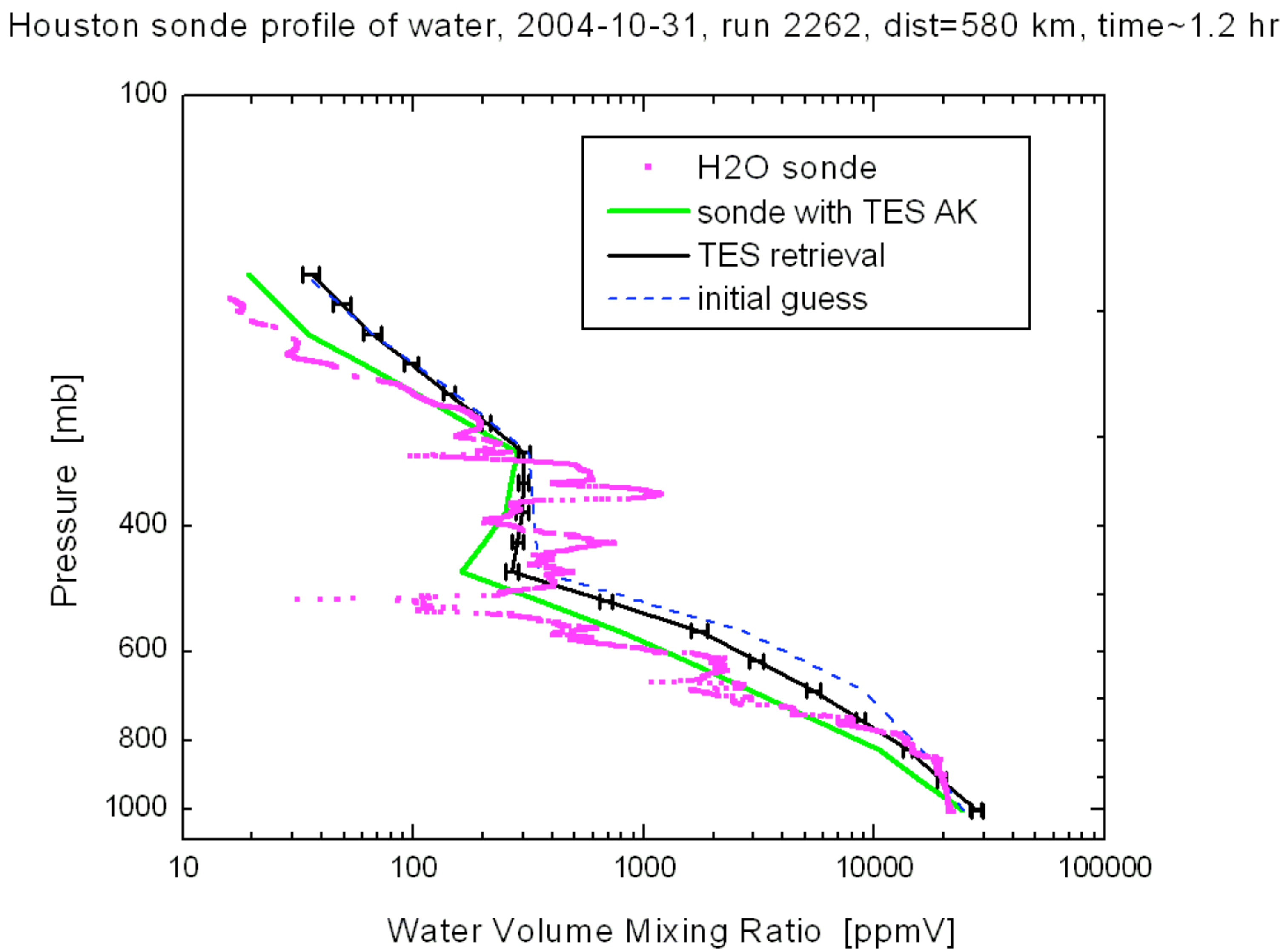
TES and MLS

- MLS data unscreened
- TES 7% wetter than MLS at 316mb
- TES 30% wet at 215mb
- TES 7% wet at 146
- Horizontal inhomogeneity as well as vertical sensitivity contribute to differences.



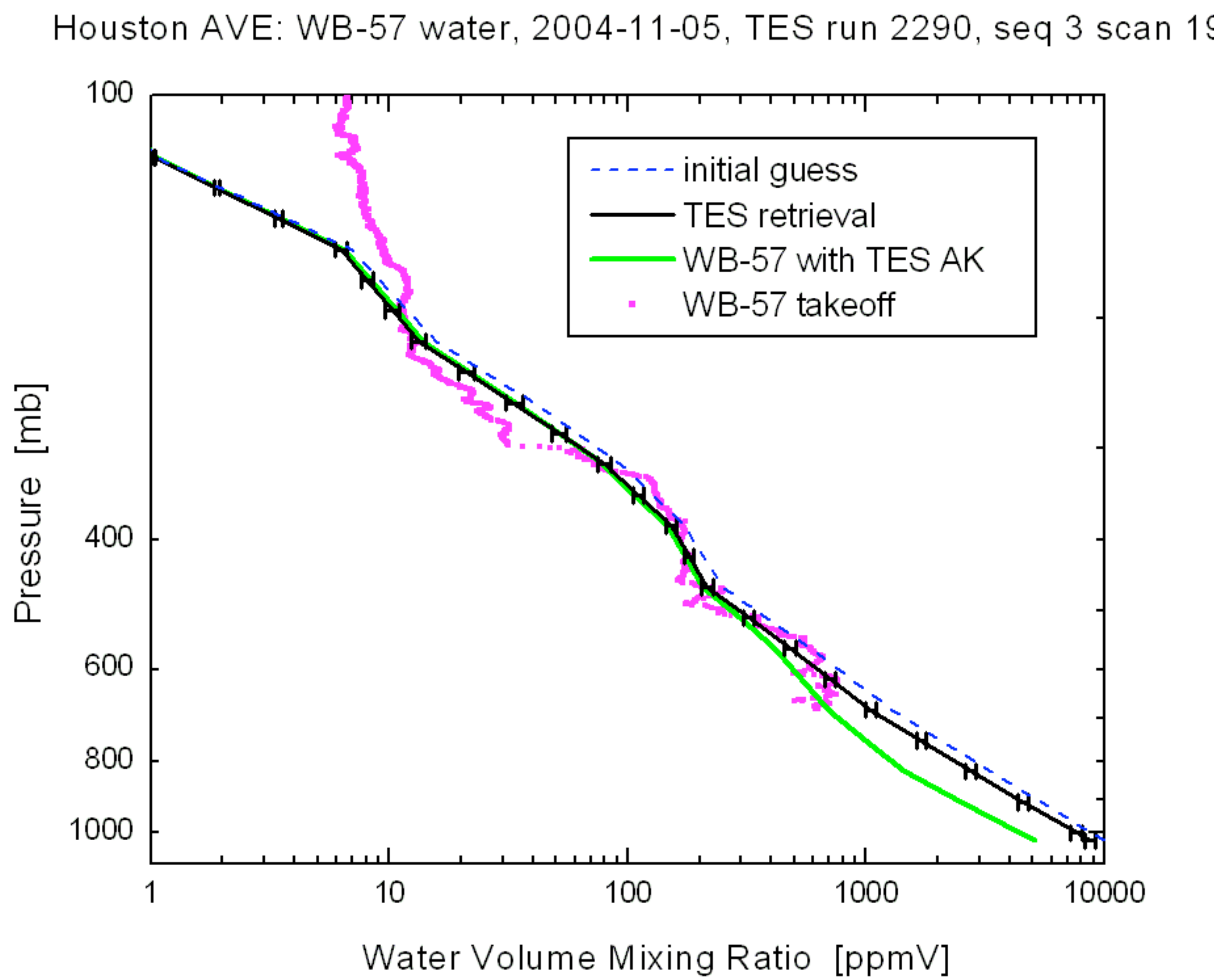
A. Eldering

TES / RS-80 comparison



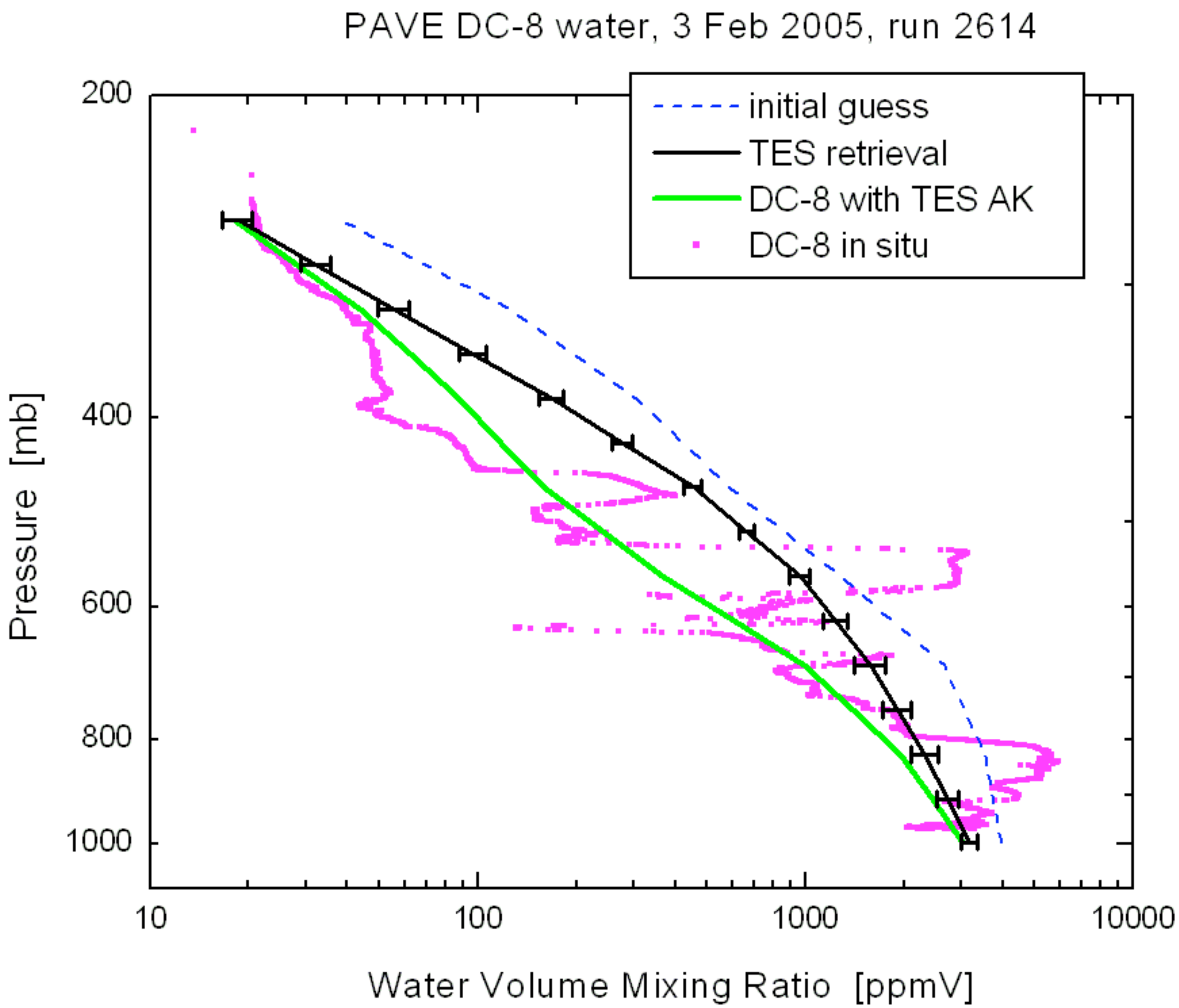
B. Herman

TES/WB-57 comparison



B. Herman

TES/DC-8 comparison



B. Herman

Conclusion from Bob Herman

High spatial variability of tropospheric water vapor suggests that a very large number of profiles are required to compare water with TES.

MLS comparisons: remote sounders and satellites

- WVMS
- Ramen lidar
- Mk-IV
- FIRS-2
- POAM
- HALOE
- AIRS
- ACE
- SAGE-II
- GPS (wasn't useful for water comparisons)

Water Vapor Millimeter-wave Spectrometer (NRL)

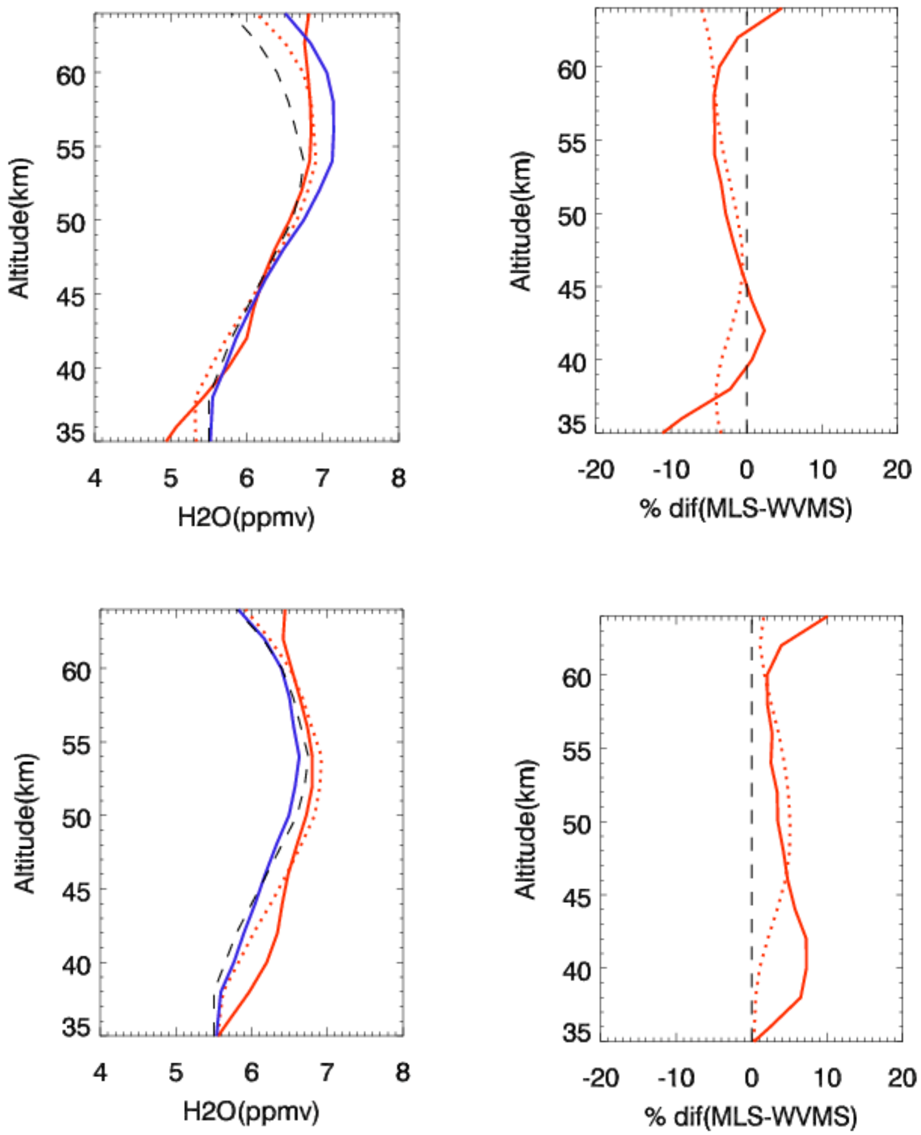
MLS-WVMS comparisons
Year-long averages

Solid red= Unconvolved MLS

Dotted red= Convolved MLS

Solid blue= WVMS

Dashed= WVMS a priori



Above 35 km

G. Nedoluha

Water vapor Raman lidar, and PTU radiosondes at JPL/TMF

Lidar: Vibrational Raman technique. Emission at 355 nm. Reception at 387 nm (Raman N2) and 407.5 nm (H20). The ratio of the corrected lidar signals at these two wavelengths is proportional to water vapor mixing ratio.
Radisonde: PTU sondes with Vaisala Humicap RS-92 sensors

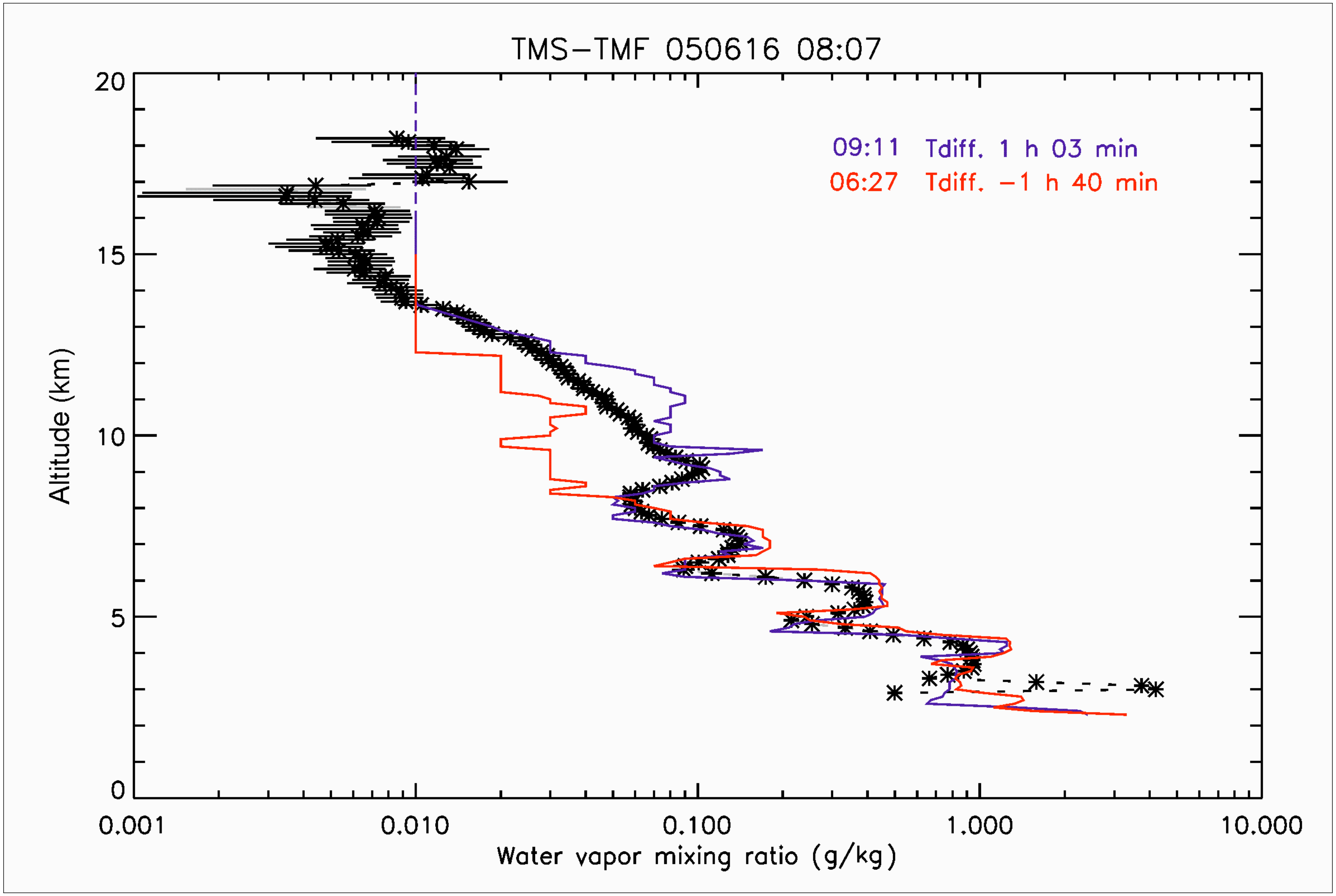
- **TMF:**
  - 50 miles NE of Los Angeles
  - Lat: 34.4ºN
  - Long: 117.7ºW
  - Alt: 2285 m (7500 ft)

    > 340 clear nights/year

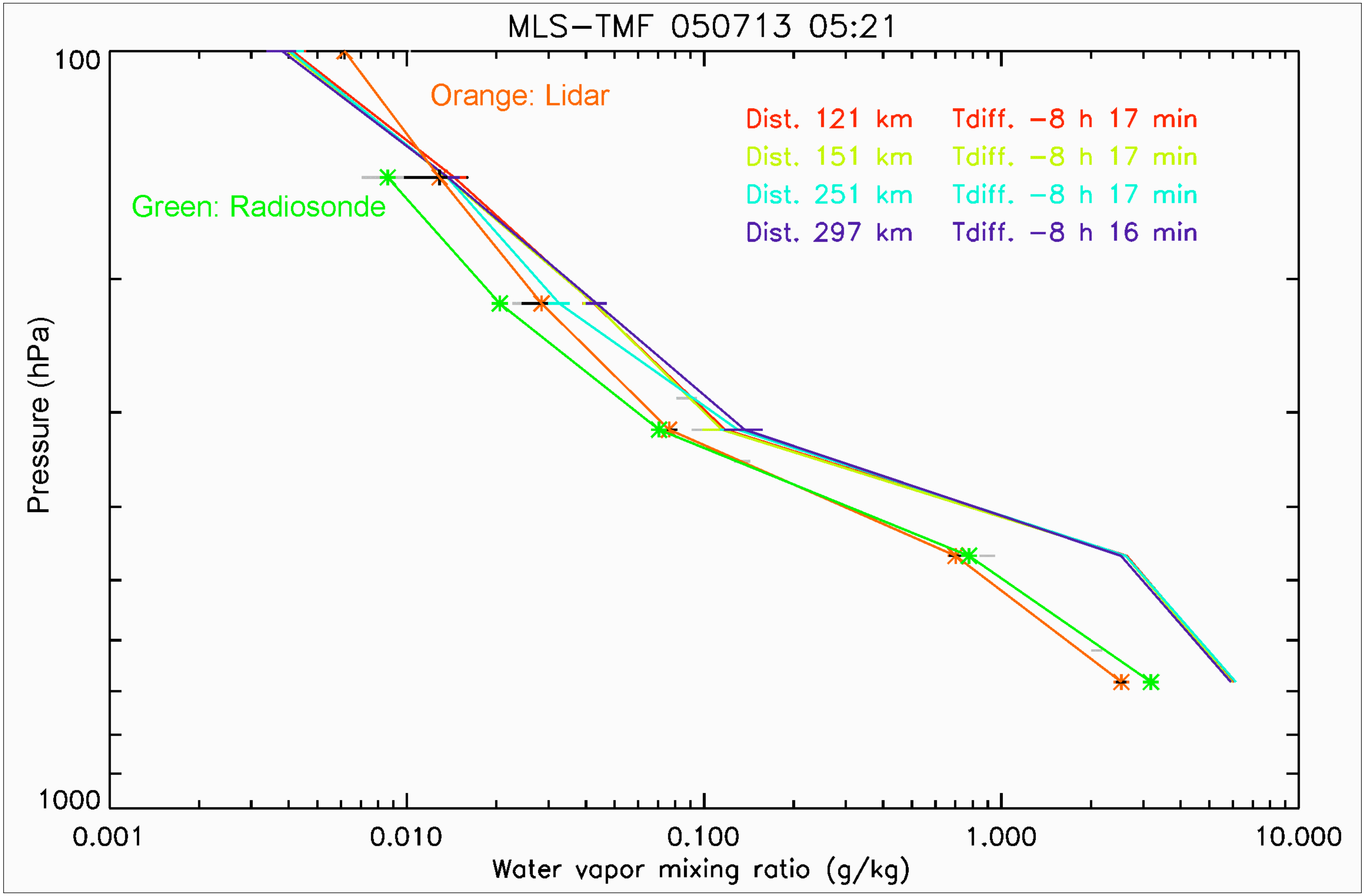
Dataset (TMF water vapor measurement program started in late 2004)

- **November 2004 – Present**:
  - Radiosonde P,T, (2.3-20 km), RH (2.3-15 km)
- **April 2005 – Present**:
  - Raman Lidar (4-19 km)
- **Lidar vertical resolution and accuracy**:
  - 75 m instrumental, 2-h routine integration (5-minutes minimum)
  - WV total error estimated to ~5 ppm at tropopause

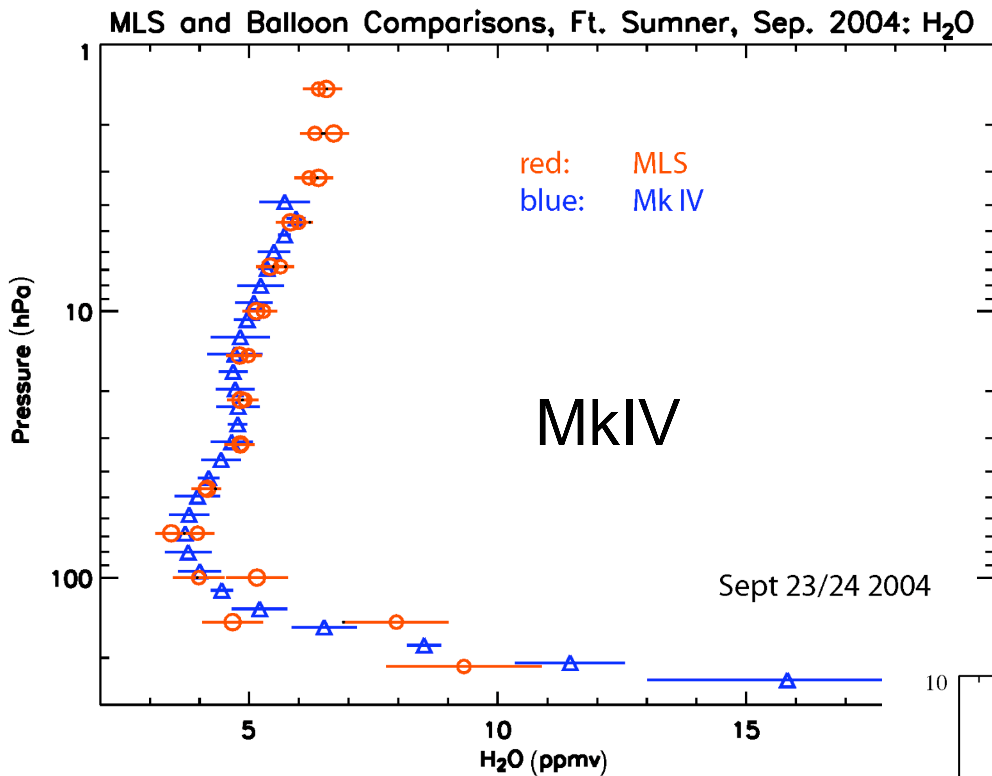
T. Leblanc



T. Leblanc Sonde-lidar comparison



T. Leblanc MLS-Lidar-sonde comparison



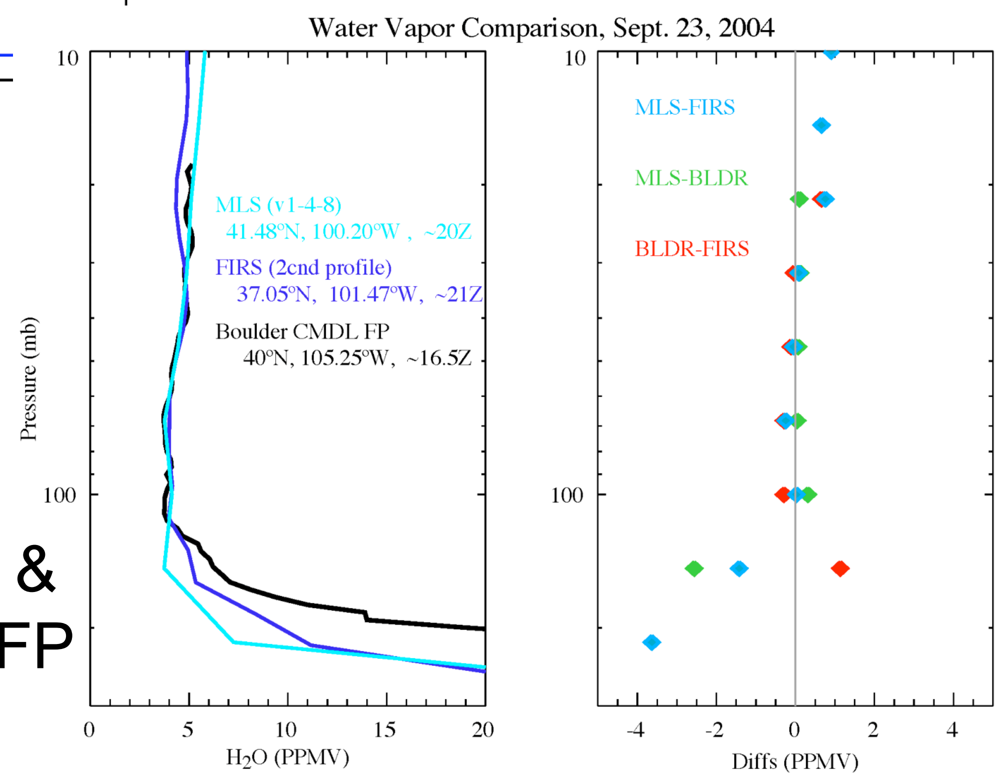
Remote sounding balloon, Ft. Sumner, Sept. 2004

MkIV data from G. Toon

FIRS-2 data from K. Jucks

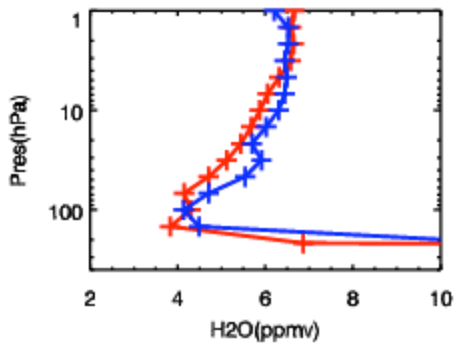
K. Rosenlof

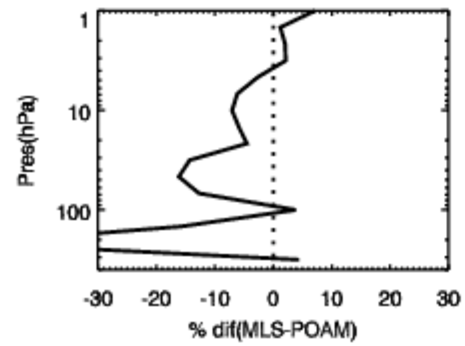
FIRS-2 & CMDL FP



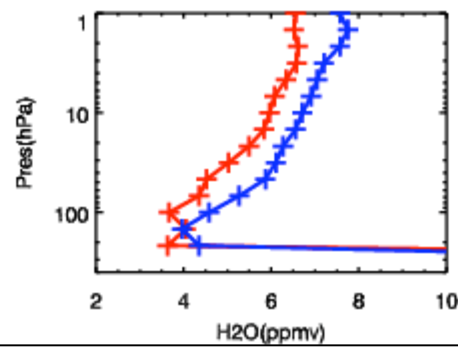
MLS-POAM comparisons: Year-long averages

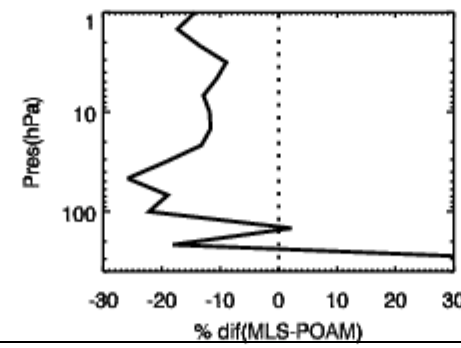
Northern Hemisphere





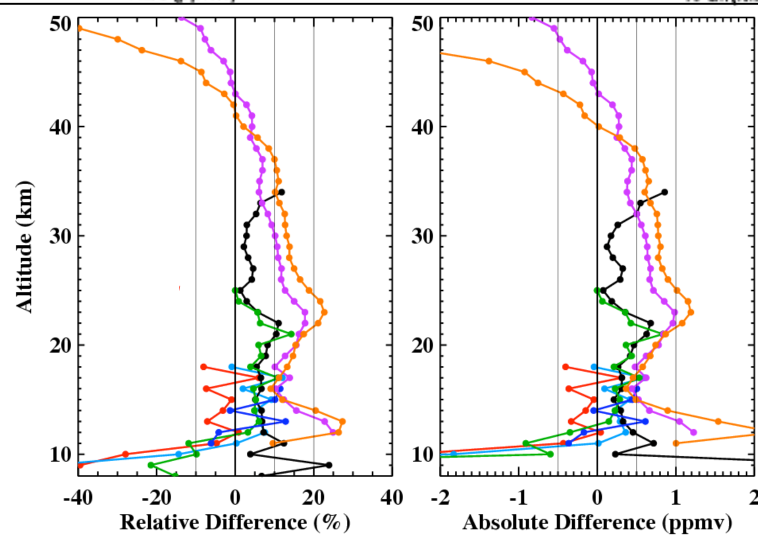
Southern Hemisphere





POAM-

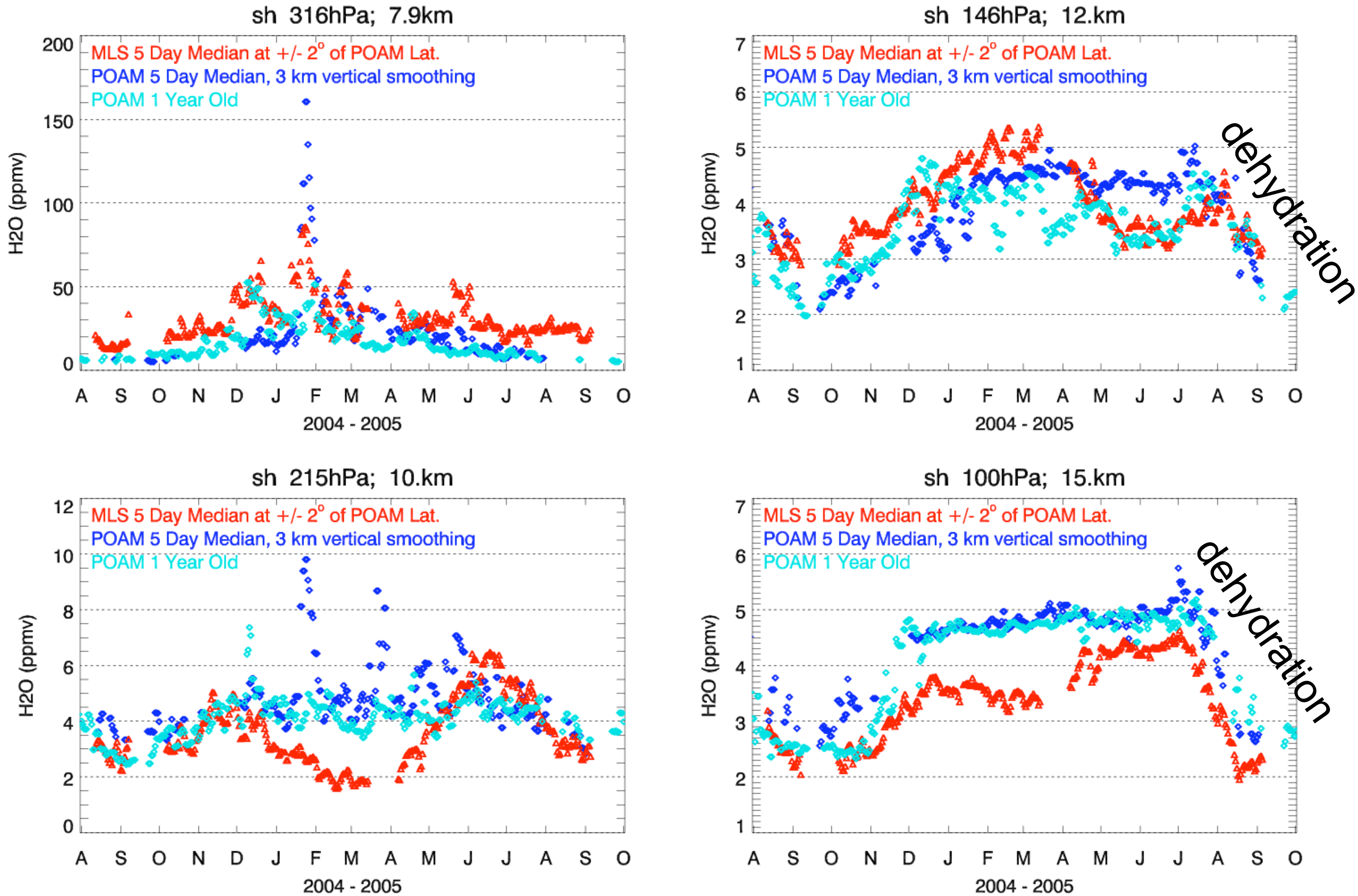
HALOE
SAGE II
MkIV
CMDL
FISH
ER-2/JPL
ER-2/HU



POAM coincidences during SOLVE II + long-term differences with SAGE and HALOE

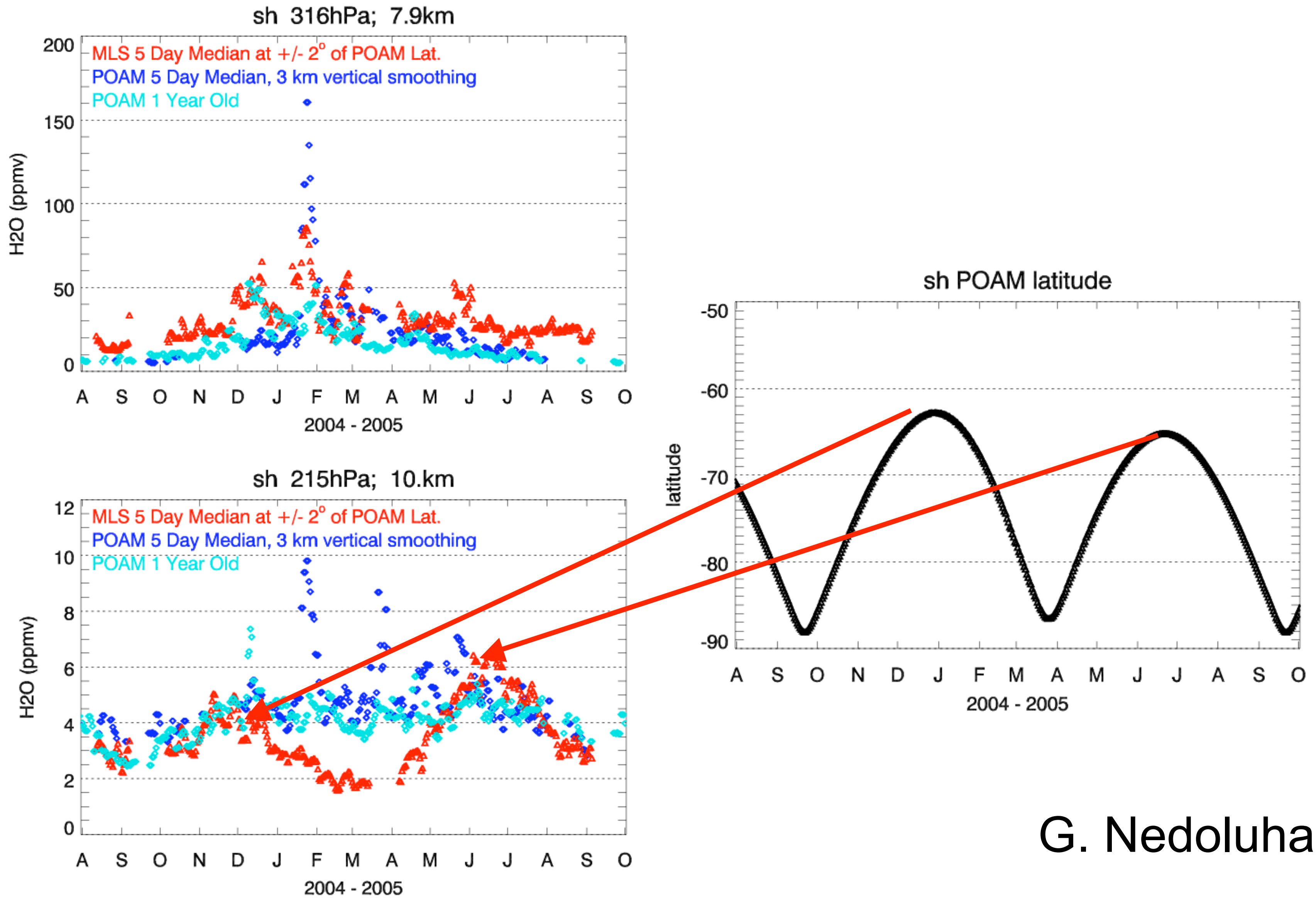
G. Nedoluha

POAM-MLS comparisons: Southern Hemisphere



G. Nedoluha

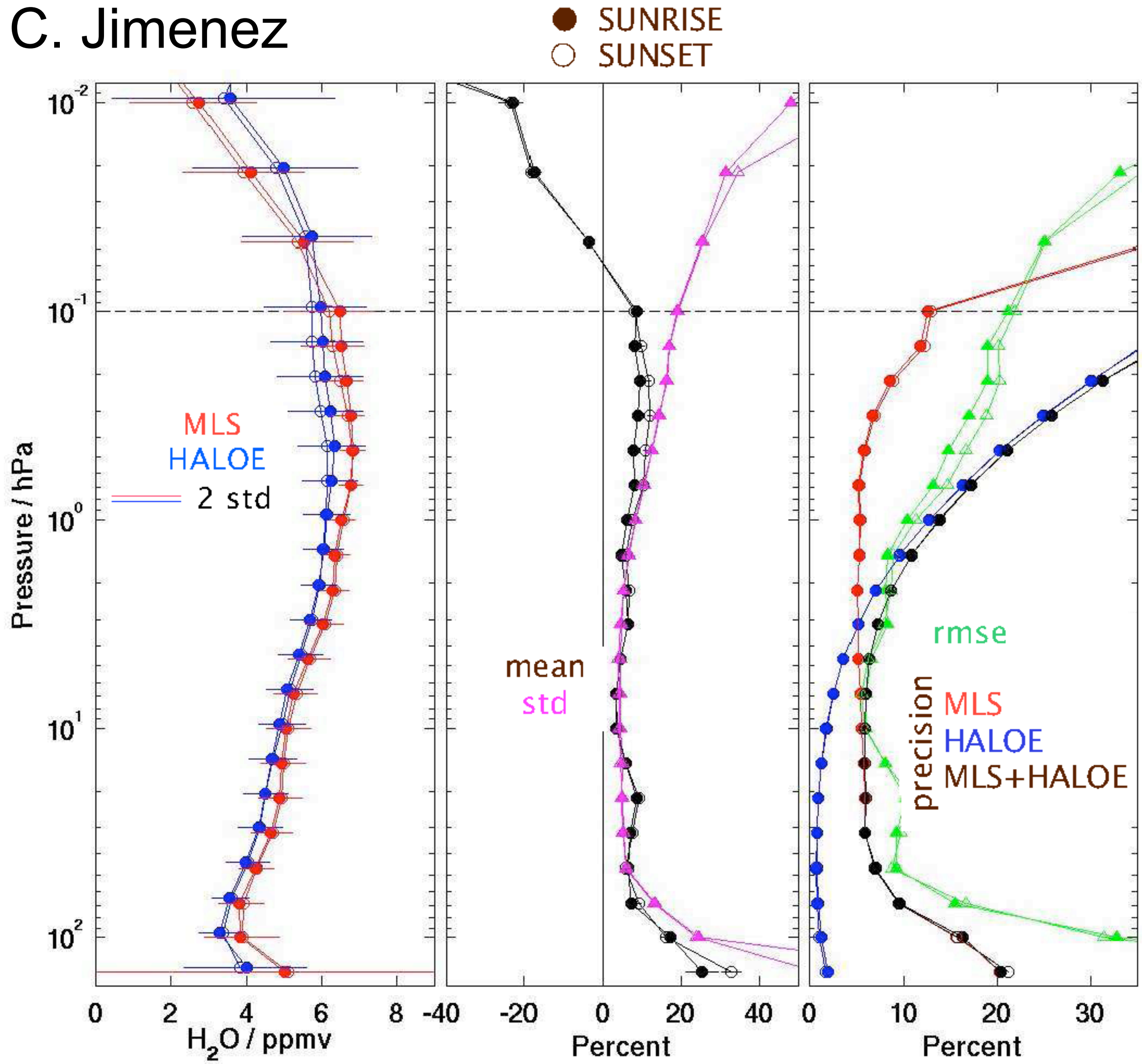
POAM-MLS comparisons: Southern Hemisphere



G. Nedoluha

Accuracy [annual averages] MLS – HALOE

C. Jimenez



~ 3800 coincidences

Stratosphere

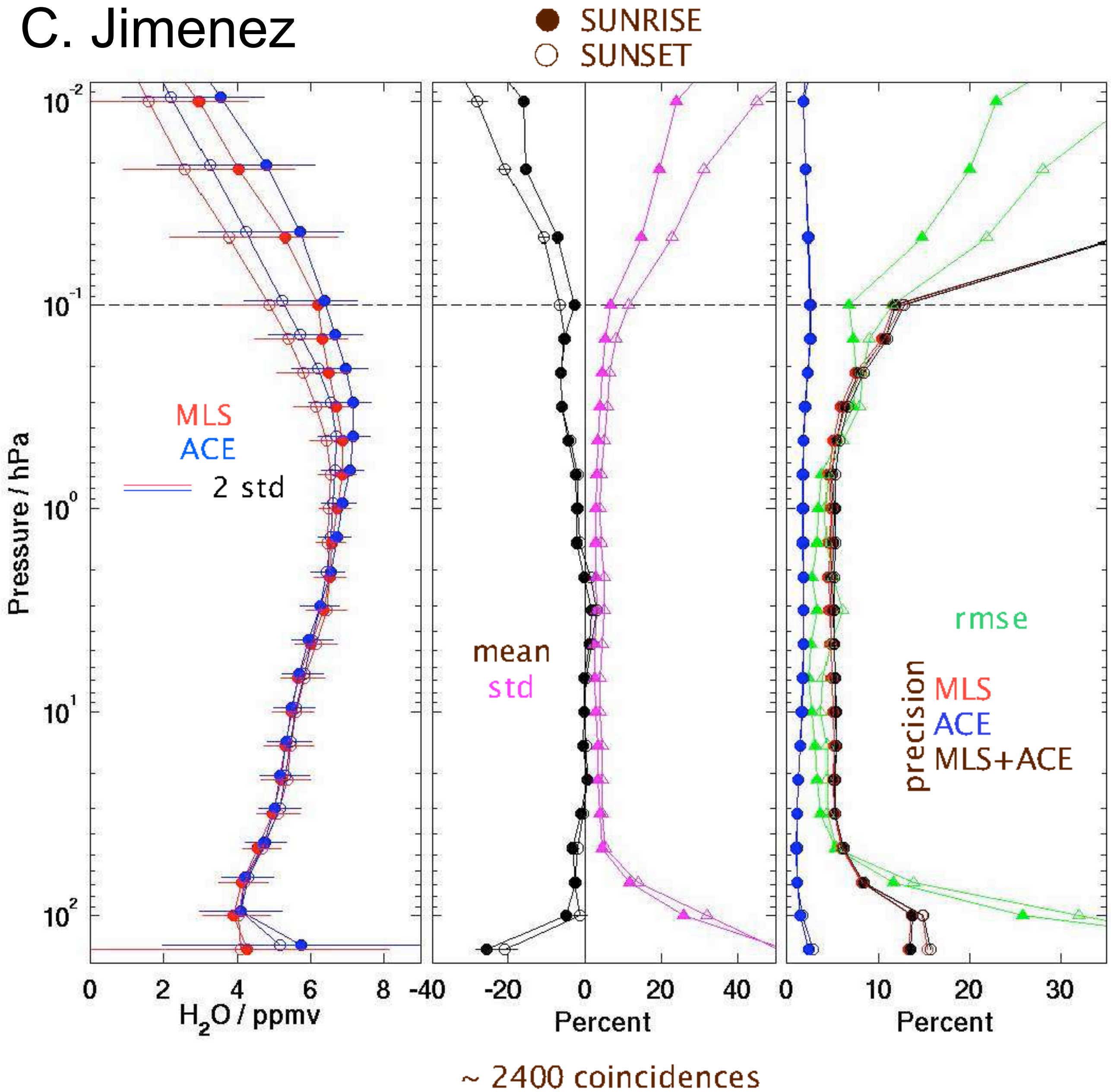
- MLS consistently wetter than HALOE, 5–10% bias.
- Biases get larger toward the lower strato.
- Reasonable agreement between rmse and combined precision, though rmse gets larger in the lower strato.

Mesosphere

- Lower mesos, MLS also wetter than HALOE, 10–15% bias, with some slight difference between sunset and sunrise.
- Upper mesos [data not recommended] seems to have a dry bias.
- Combined precision gets larger than rmse, suspected overestimation of HALOE precision.

Accuracy [annual averages]

C. Jimenez



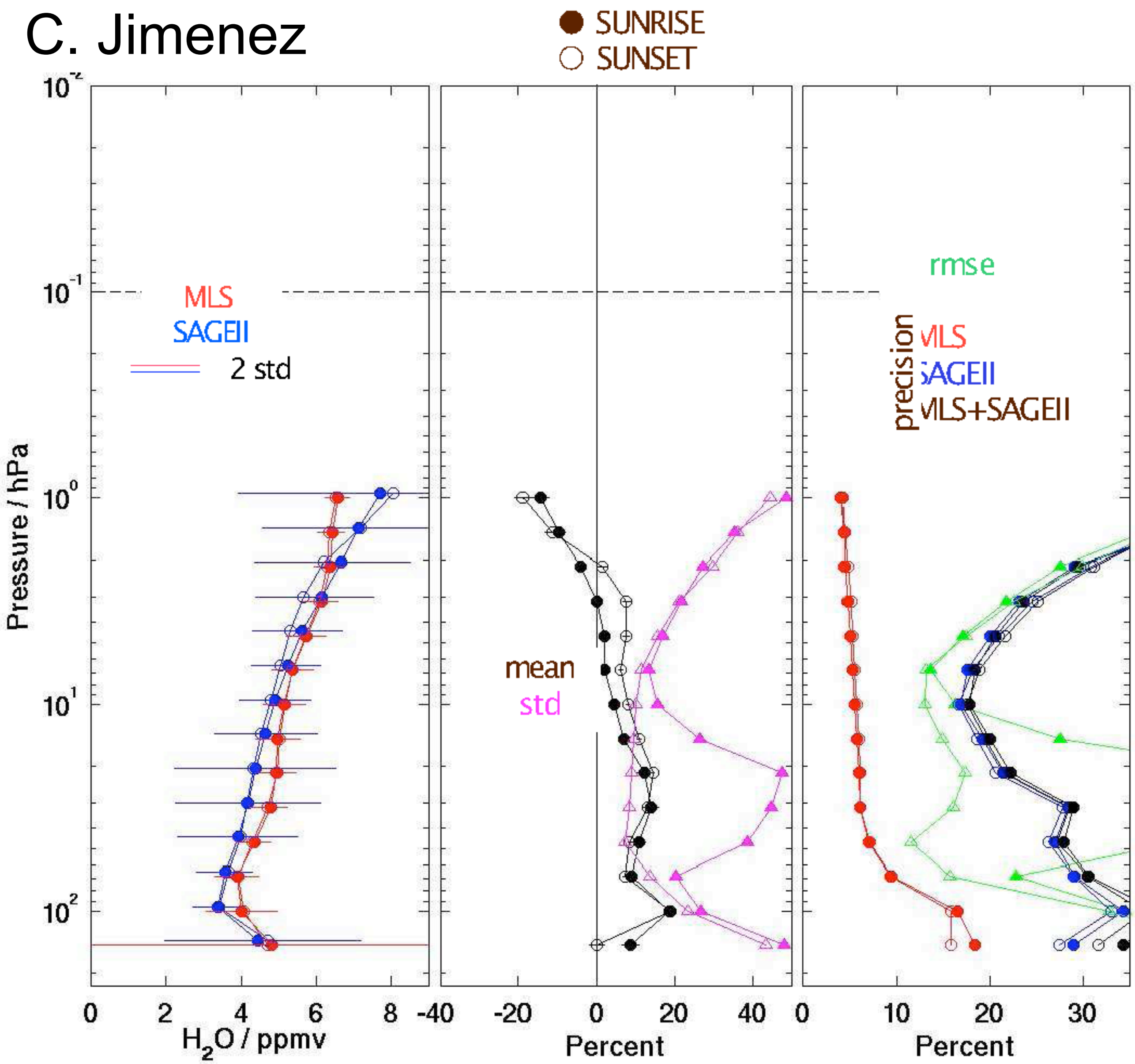
Stratosphere

- Biases of only a few percent, smaller than with HALOE.
- Dry larger bias in the very lower strato, MLS-HALOE showed a wet bias.
- No significant sunrise-sunset differences.
- Reasonable agreement between rmse and combined precision.

Mesosphere

- Dry bias, 0-10% in the lower mesos, MLS-HALOE showed a wet bias.
- Upper mesos [data not recommended] seems to have a dry bias, in agreement with MLS-HALOE.
- Combined precision larger than rmse, overestimation of MLS precision-underestimation of ACE?

C. Jimenez



~ 3700 coincidences

Stratosphere

- MLS wetter than SAGEII in the lower-middle strato, bias changing sign towards the upper strato, 10–15% biases.
- Significant sunrise-sunset differences, larger variability in the differences for the sunrise occultations.
- SAGEII precisions dominate the combined precision, reasonable agreement between rmse and combined precision.

Summary

C. Jimenez

Pressure, hPa	Vertical Resolution, km	"True" Precision, ppmv	Estimated Precision ppmv	Estimated Accuracy Difference HALOE	Difference SAGEII	Difference ACE
0.1	7	0.3	0.8	+10%		-10%
1	5	0.1	0.3	+5%	-15%	-3%
10	4	0.1	0.3	+5%	+10%	-1%
100	3	0.8	0.5	+15%	+5%	-5%

Future plans

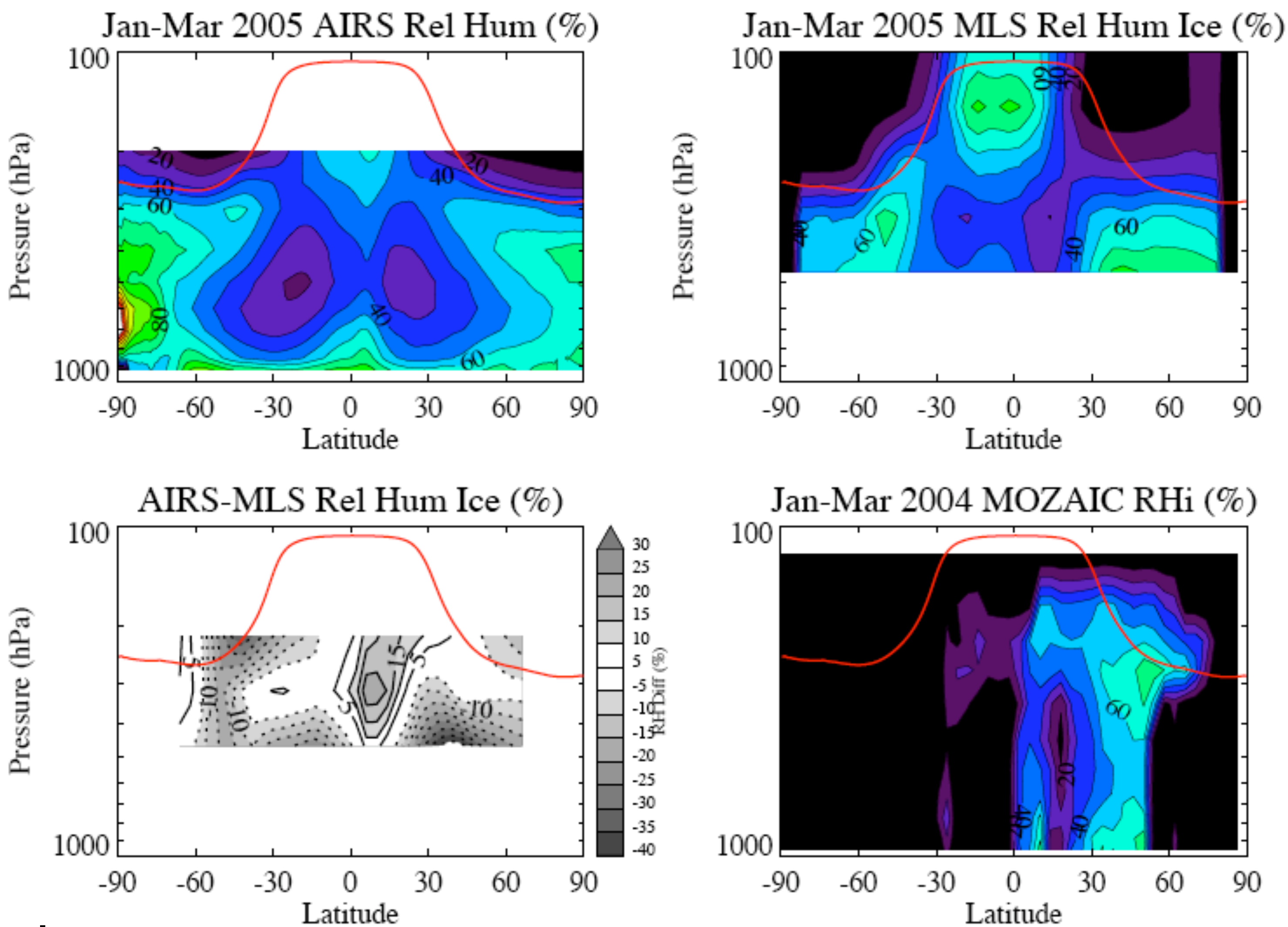
- Removing observed **zigzagging** in the lower stratosphere, trying to get better radiance closure in that region.

- Extending **retrieval vertical range** further up into the mesosphere, working towards a better tuning of the smoothing constrains in that part of the atmosphere.

- Further **validation**, updating from the rest of comparisons presented at the meeting.

Zonal Mean RH comparisons

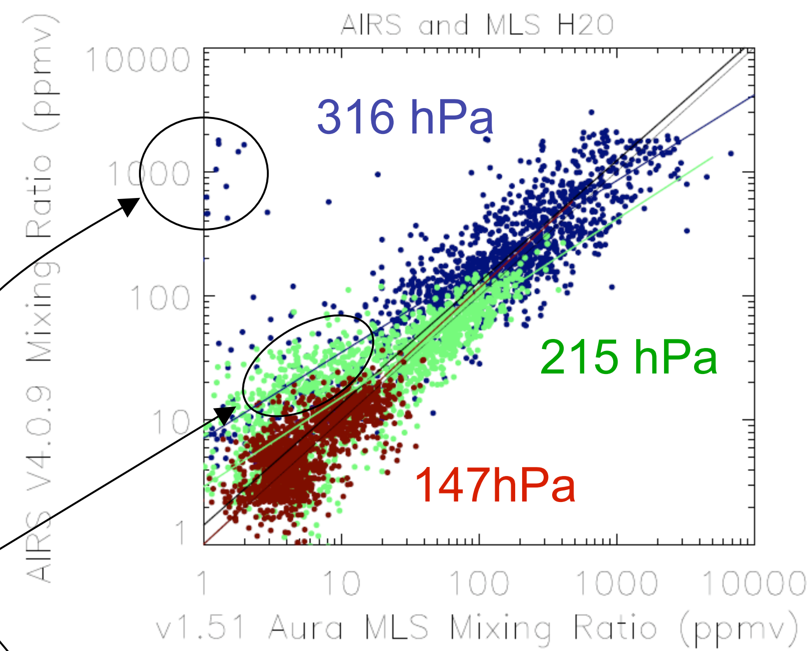
MLS v. AIRS ±15%, AIRS moist (316mb), MLS dry (460)

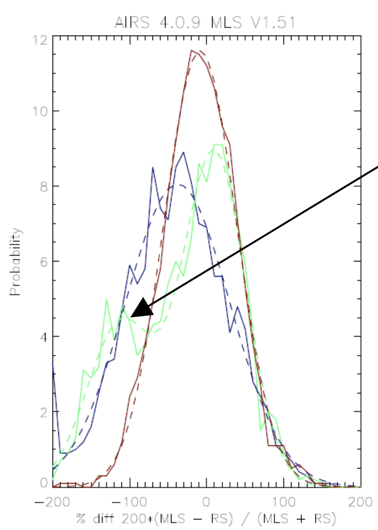


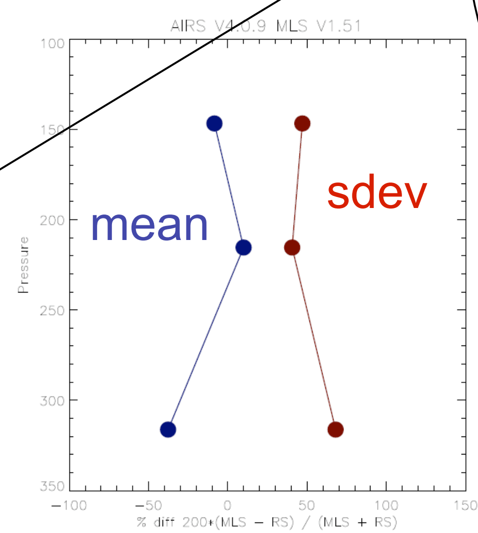
A. Gettelman

AIRS V4.0.9

- Two days per month from Aug 04 to Aug 05. (86445 profiles, 82°S--82°N).
- As with other comparisons, scatter is LARGE
  - Almost identical to RS at 316 hPa.
  - Smaller than RS at 215 hPa
  - Increases again at 147 hPa







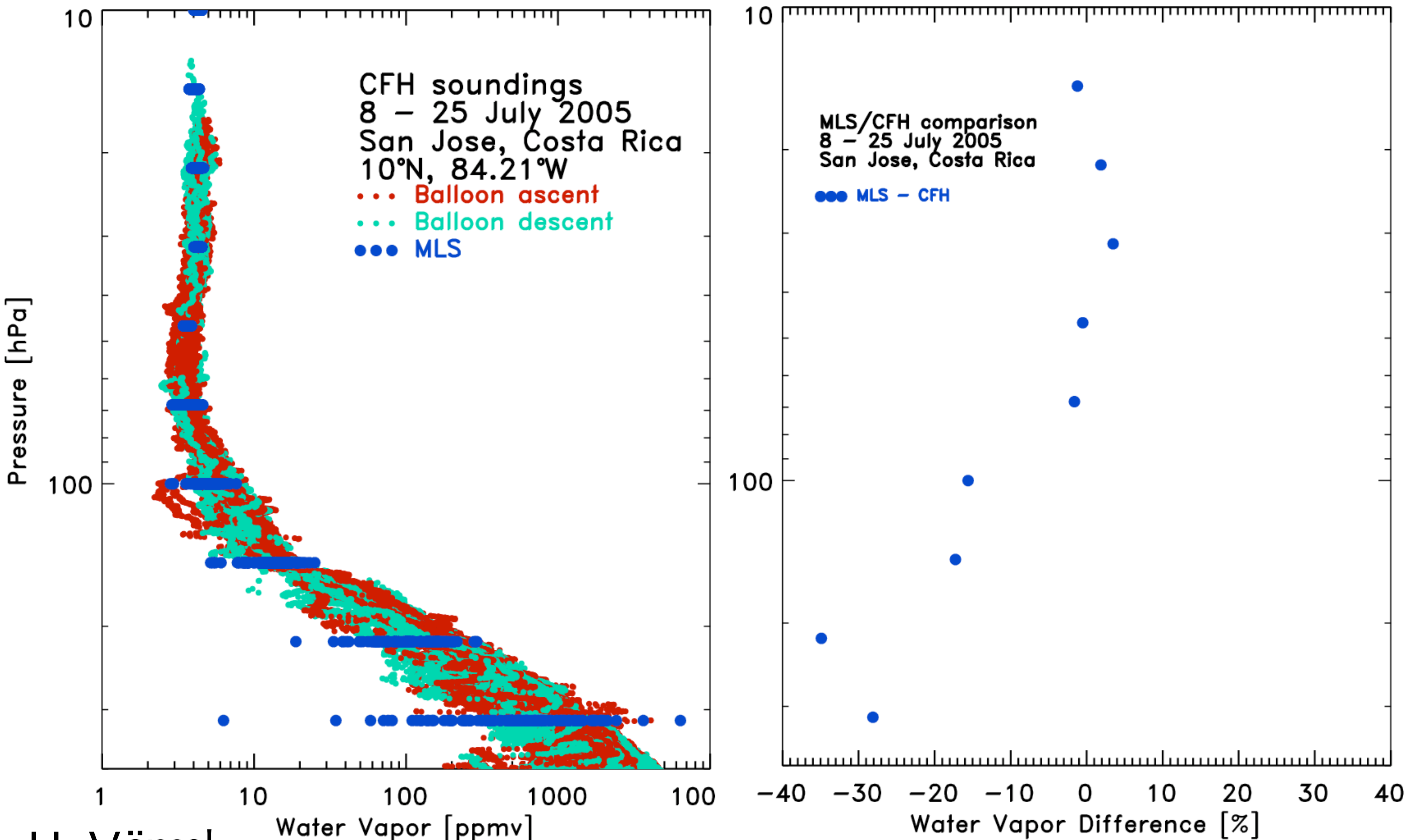
- MLS-AIRS PDF at 215 hPa is bimodal.
  - Probably a data screening problem
  - These occur north of 60°N.
- Dry fliers in MLS data.
- The increased scatter at 147 is not a good sign.

B. Read

In situ comparisons with MLS

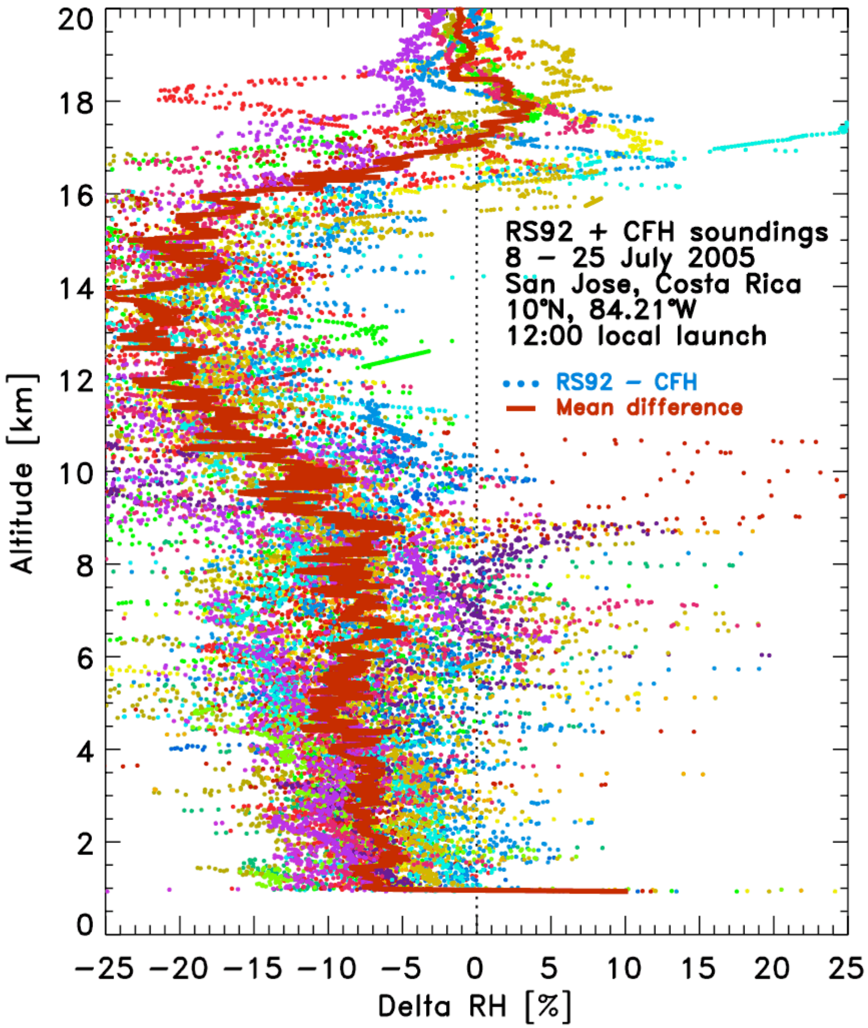
- Chilled mirror instruments (CU-CFH & Snow White)
- Operational radiosondes (RS92s)
- Aircraft measurements

MLS/FP comparison

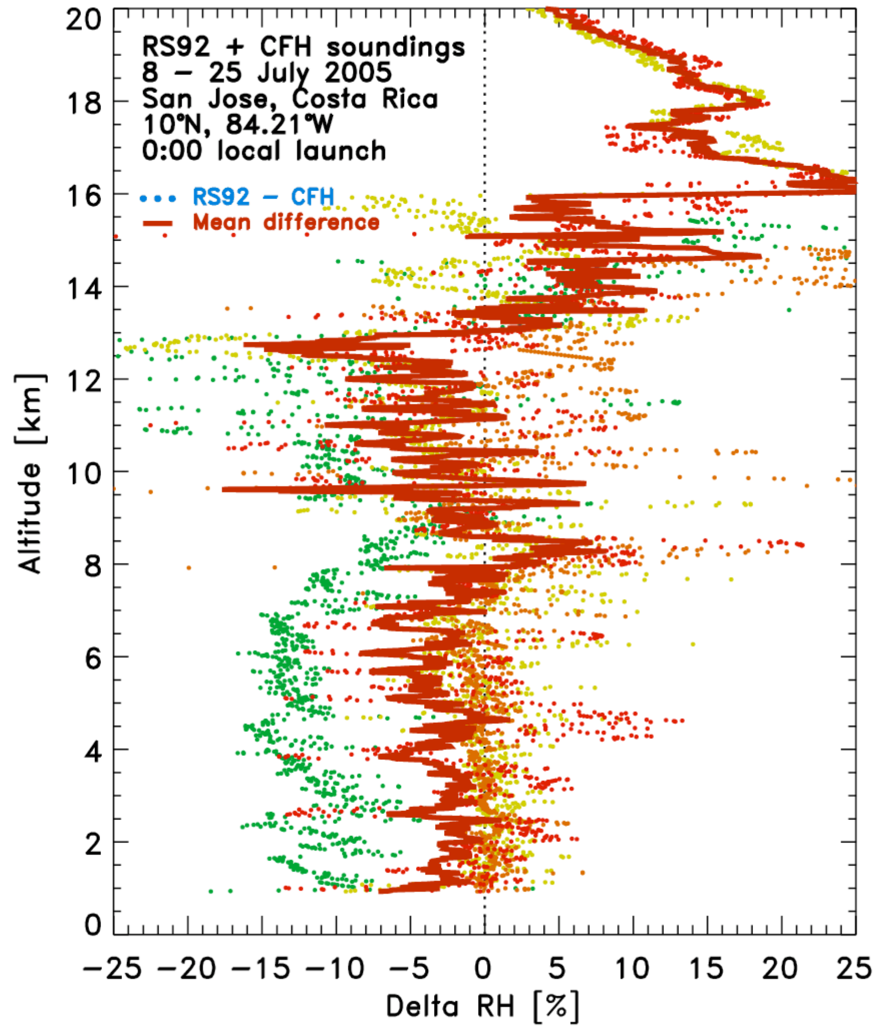


H. Vömel

RS92 comparison



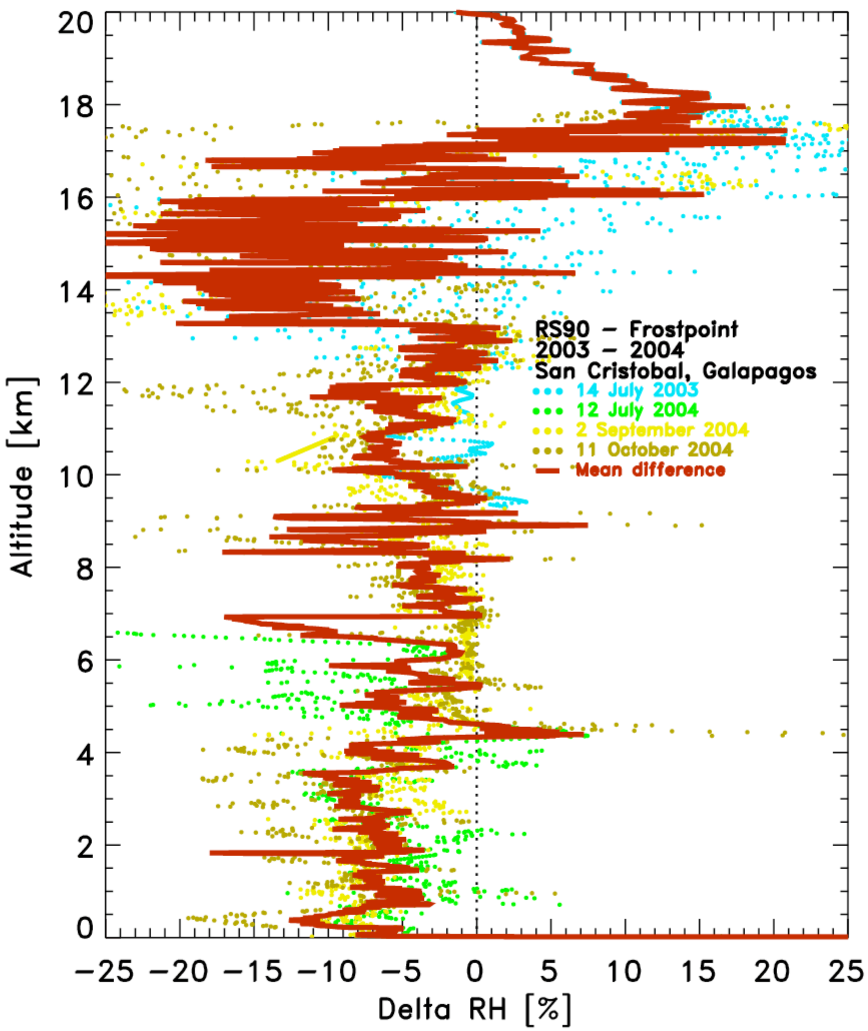
Daytime



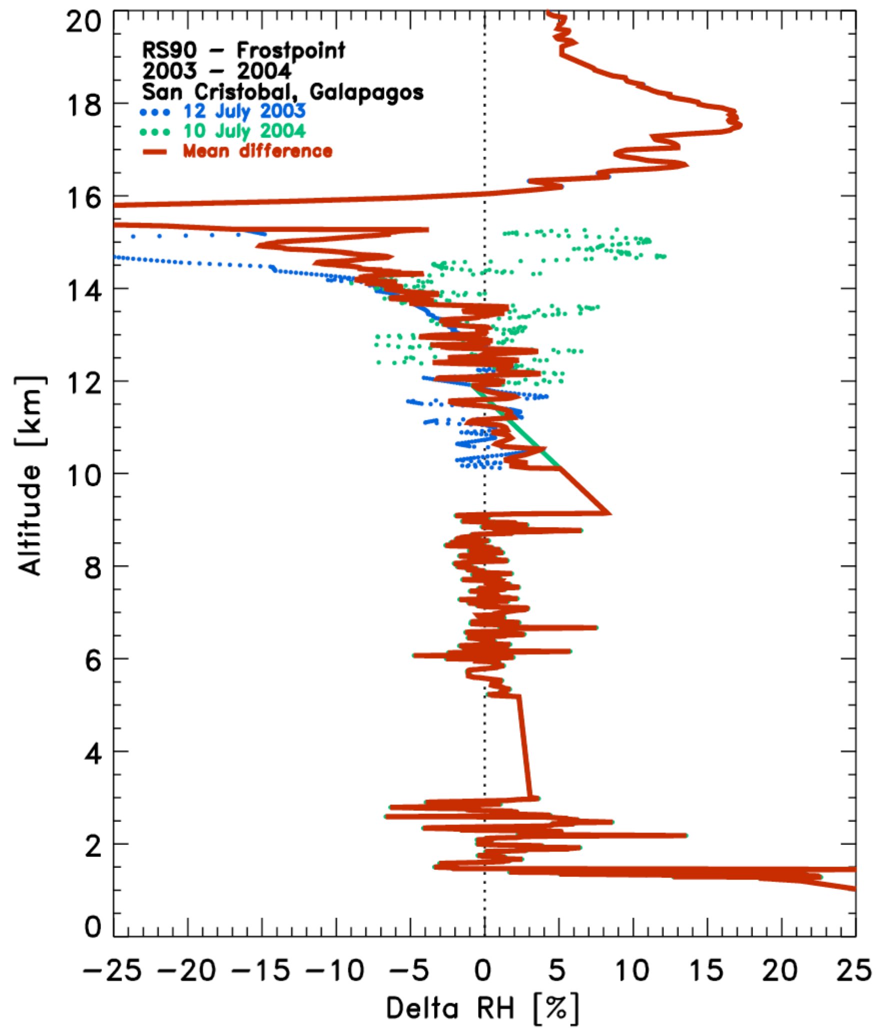
Nighttime

H. Vömel

RS90 comparison



Daytime

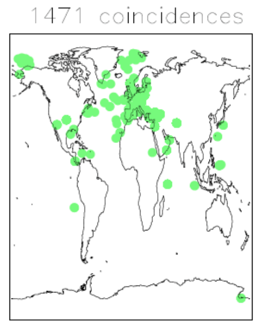


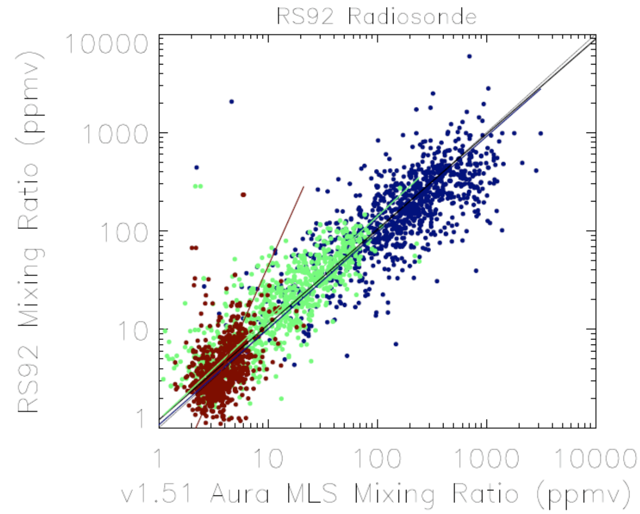
Nighttime

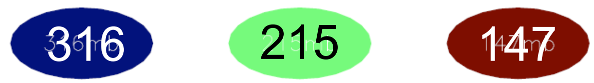
H. Vömel

Radiosondes

Vaisala RS92



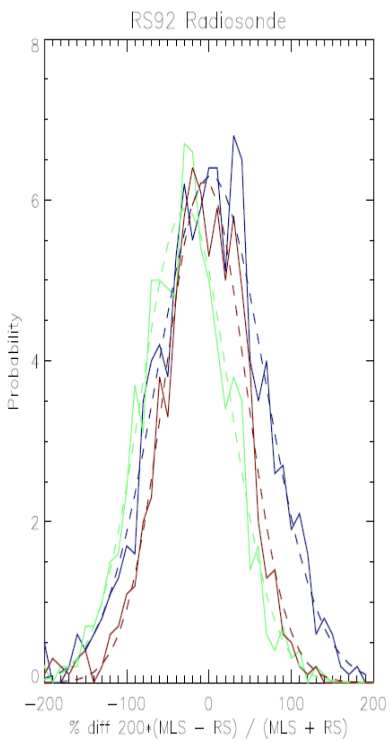


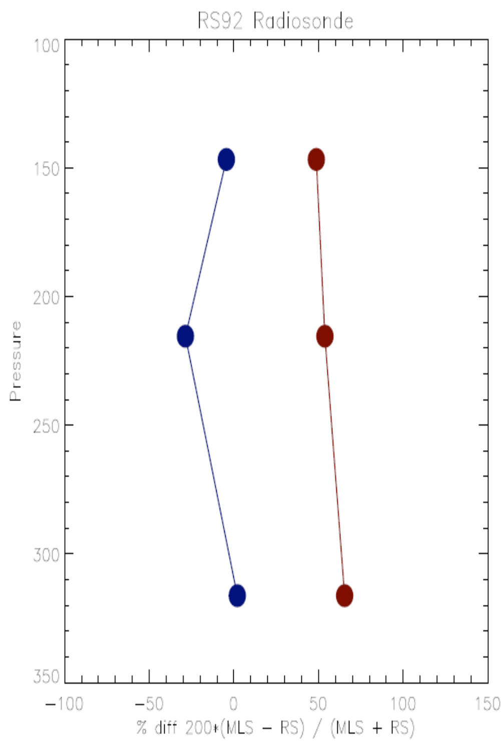


PDFs

Mean Difference

Std dev of differences



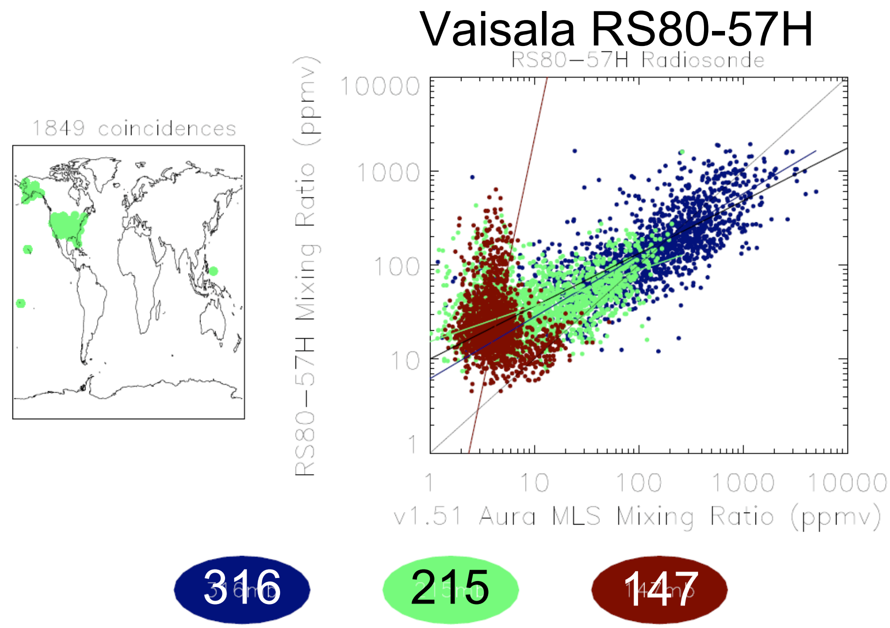


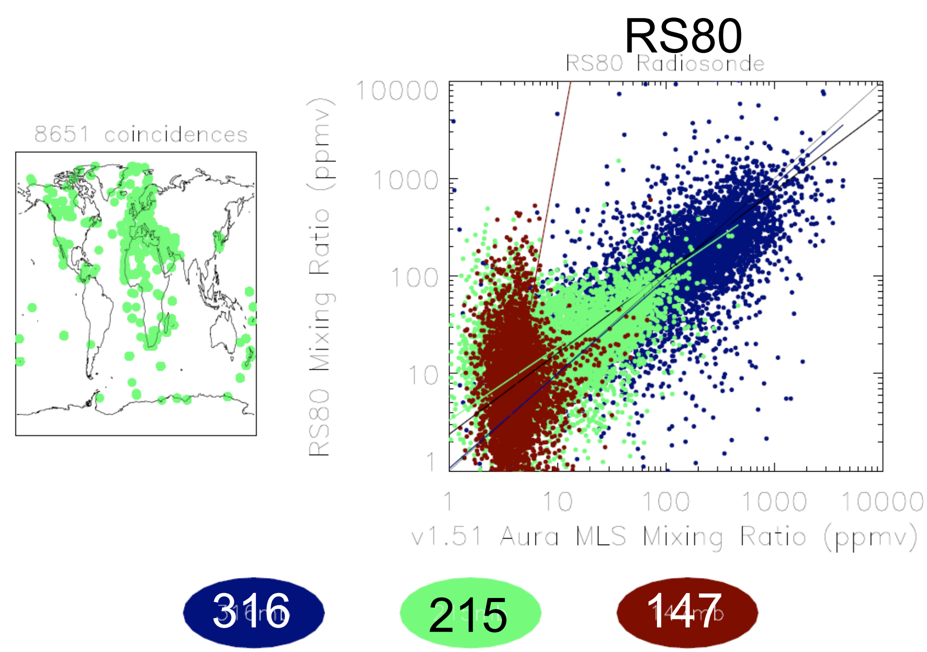
- RS92 radiosonde shows good agreement
- Lots of scatter
- RS90 is similar but with poorer agreement at 215 and 147 hPa.

B. Read

RS80/RS80-57

- RS80 is the workhorse instrument in the network – 316 and 215 levels are decent but starts to lose it at 147 hPa
- RS80—57H is a variant of the RS80 (presumably using the H dielectric) adopted by the US.
  - It shows much worse agreement than RS80
  - Don’t know why. Possibly uses a data reporting practice to make data consistent with older US radiosondes?



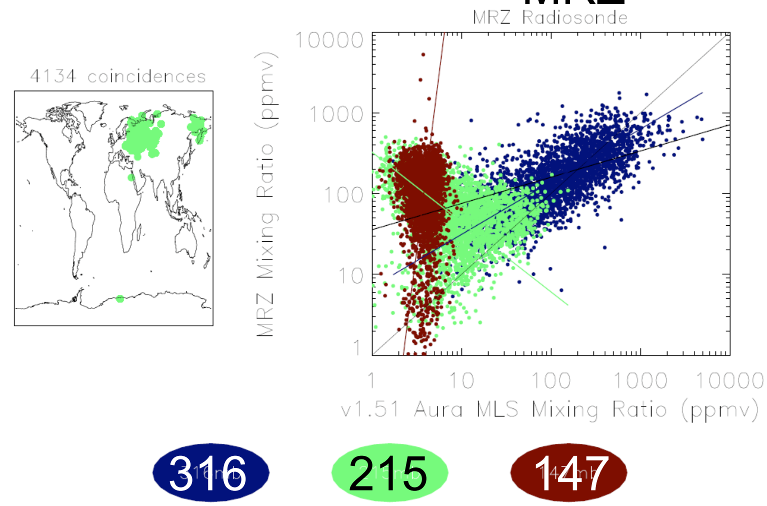


B. Read

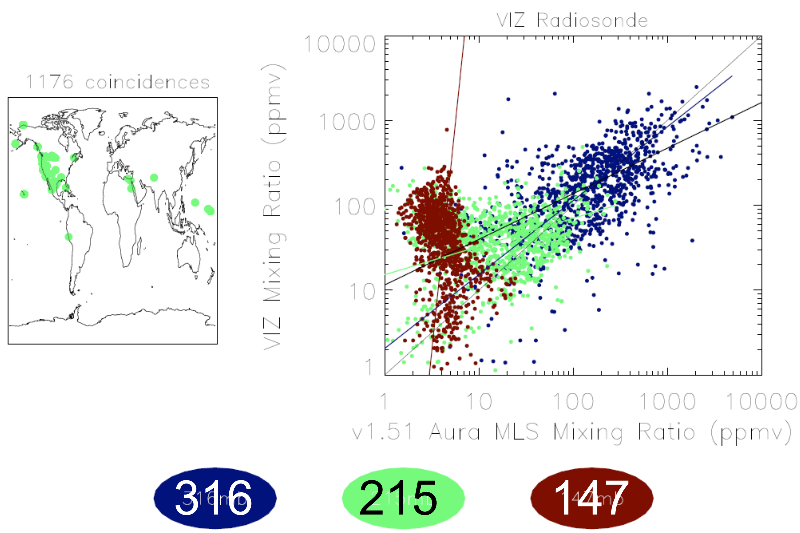
US VIZ / Russia MRZ

- Relative to MLS x-axis, these radiosondes show a severe degradation of performance at 215 and 147 hPa.
- Agreement at 316 hpa is better but not as good as the Vaisala.

MRZ

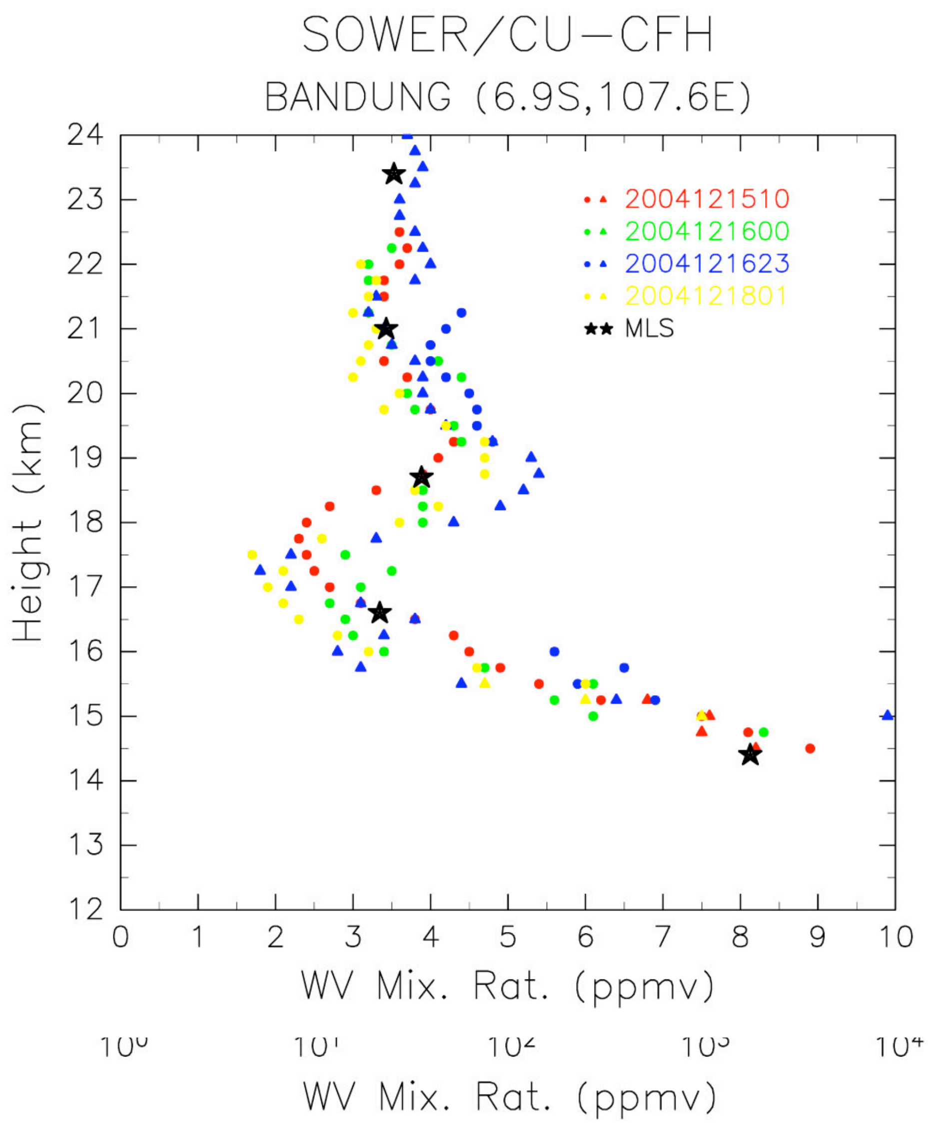


VIZ



B. Read

Comparison with CU-CFH

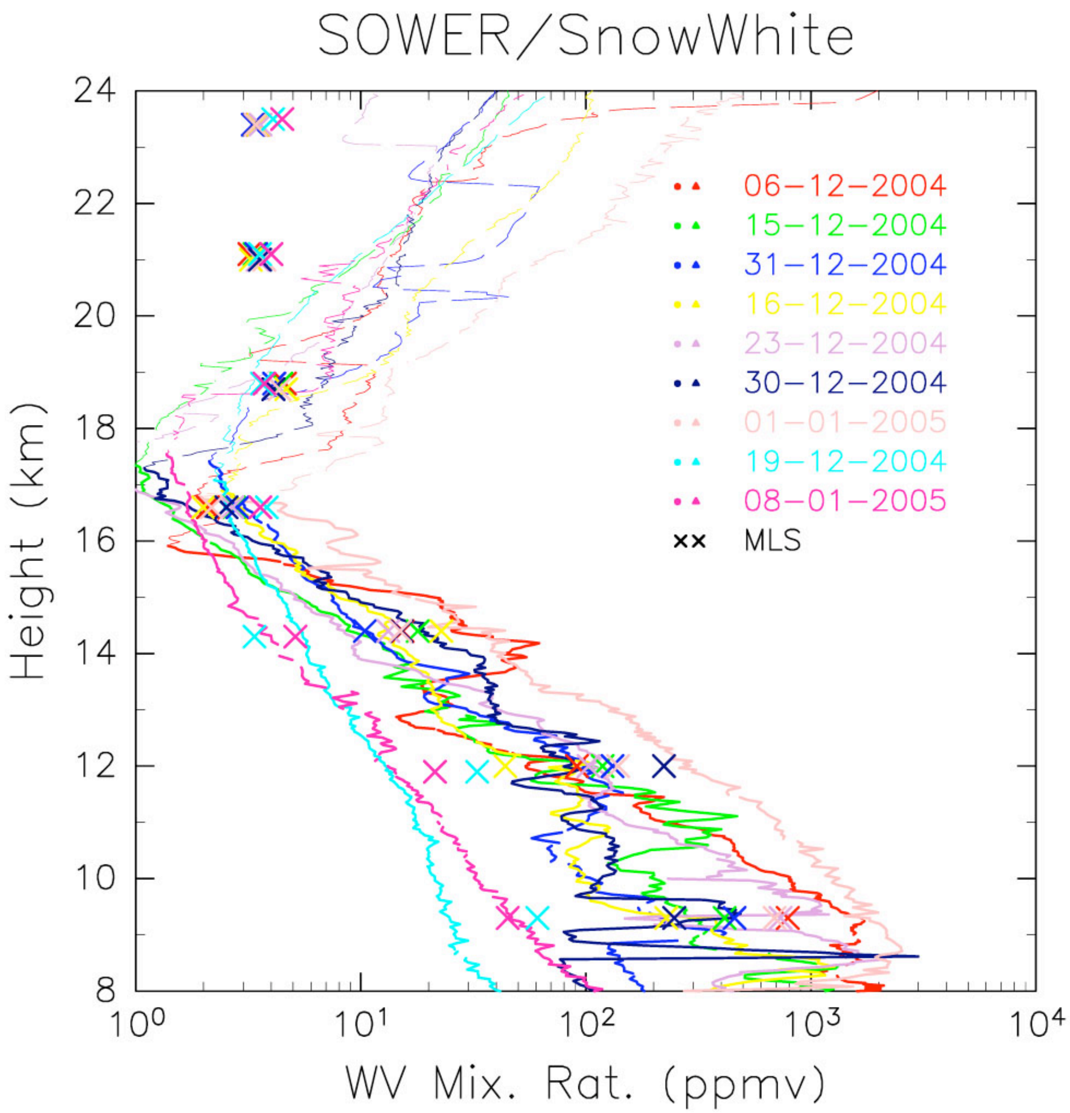


Coincidence is defined as +/-3 deg & +/- 14 hours (data processed by A. Gettelman)

1 coincidence out of 4 observations

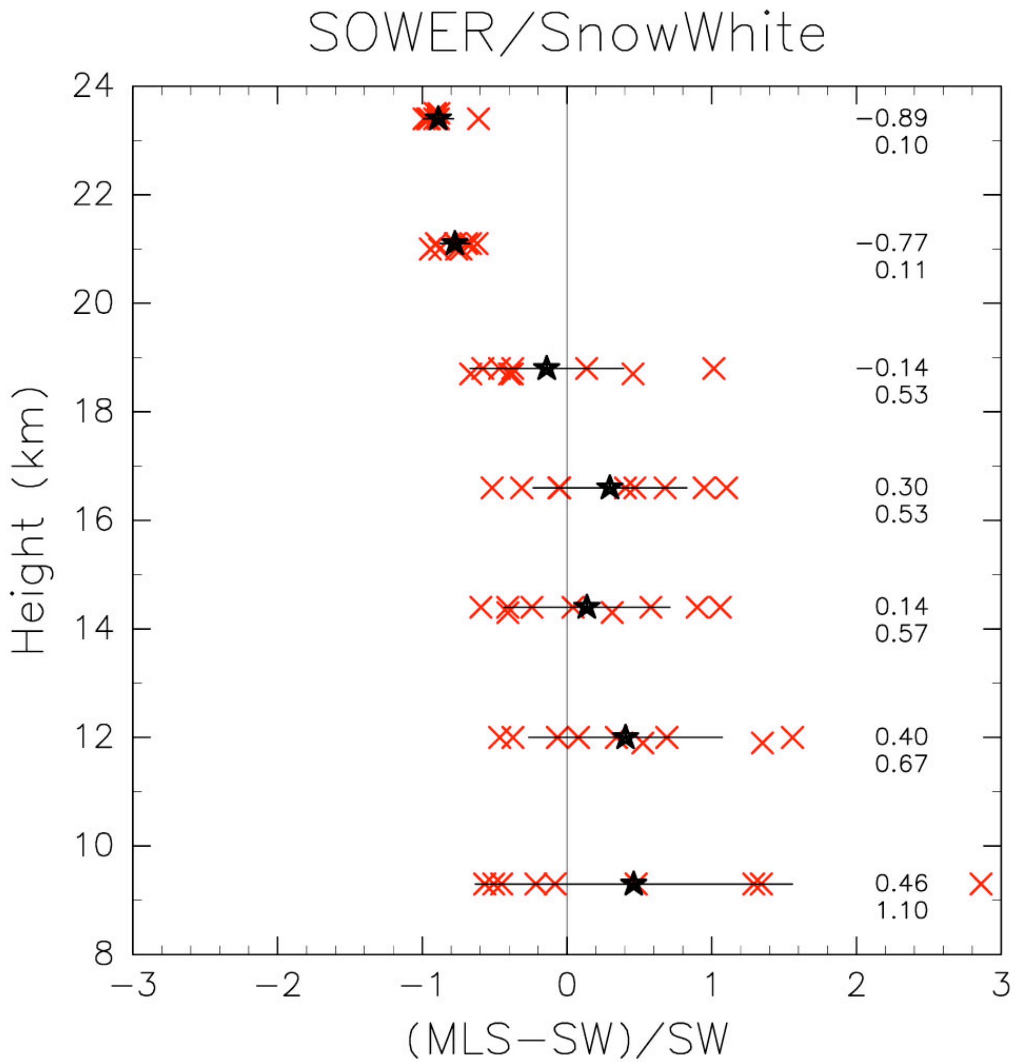
M. Shiotani

All Snow Whites

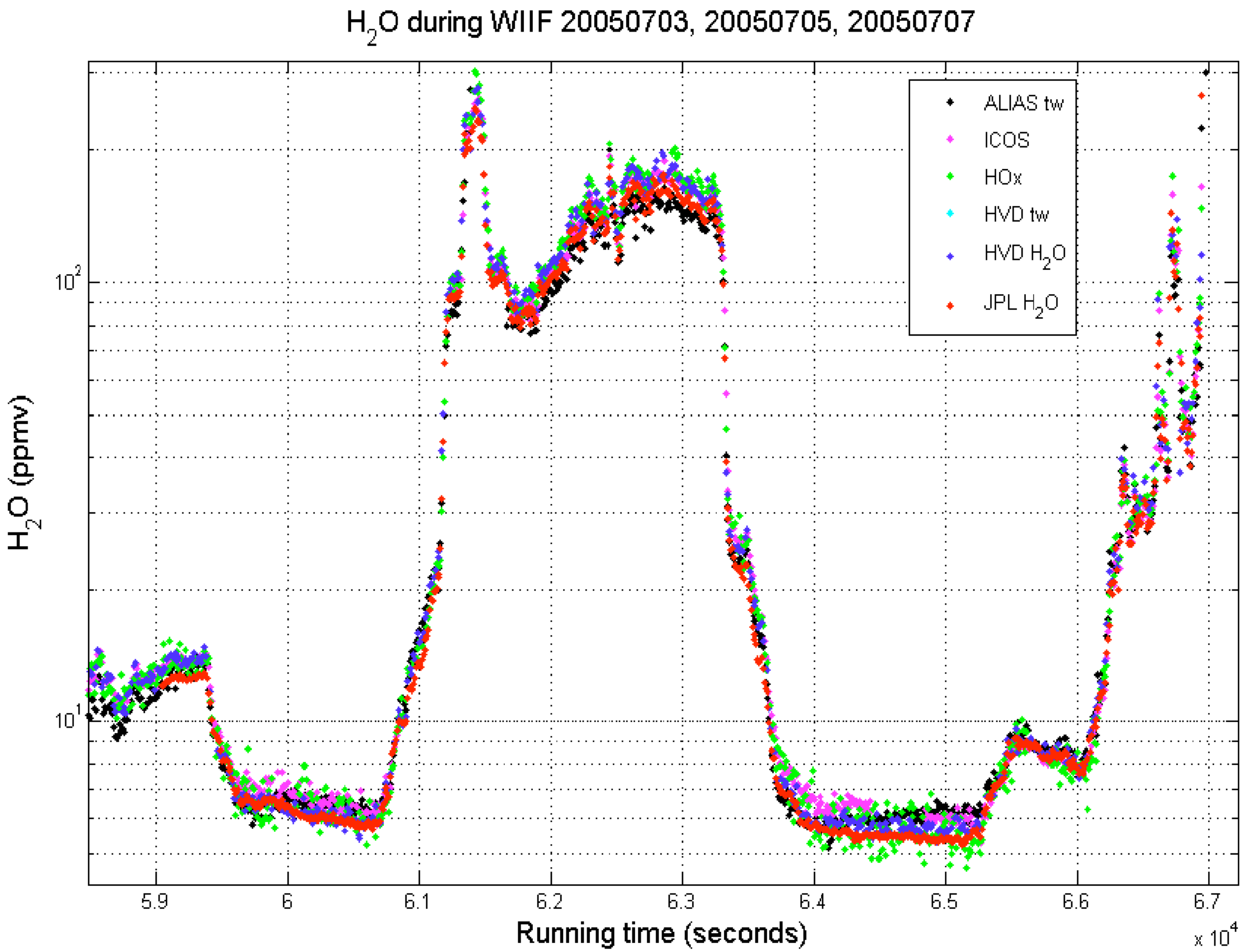


M. Shiotani

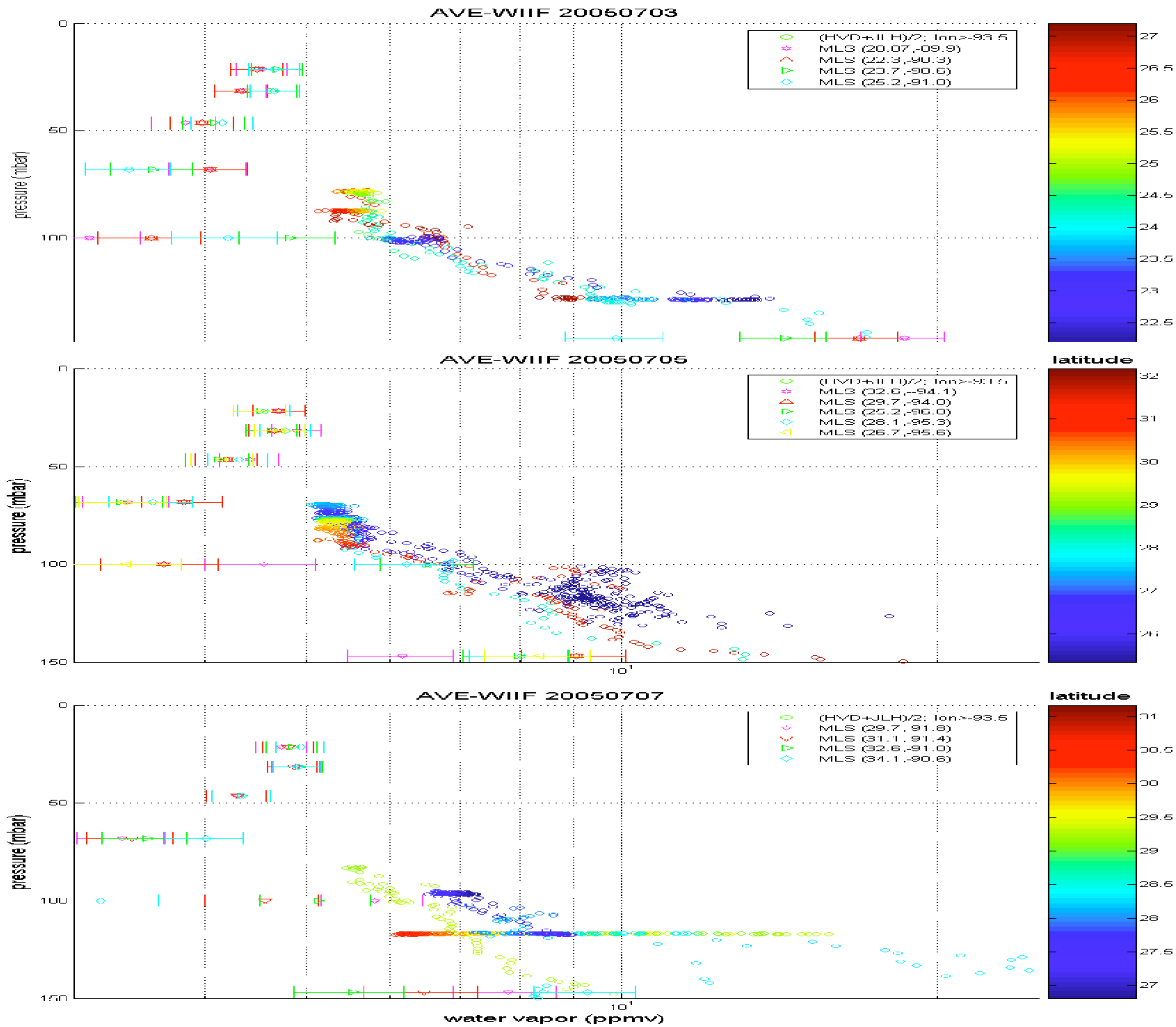
Statistical Summary



M. Shiotani


H2O during WIIF 20050703, 20050705, 20050707
H2O (ppmv)
Running time (seconds)
x 10^4
ALIAS tw
ICOS
HOx
HVD tw
HVD H2O
JPL H2O
10^2
10^1
5.9
6
6.1
6.2
6.3
6.4
6.5
6.6
6.7

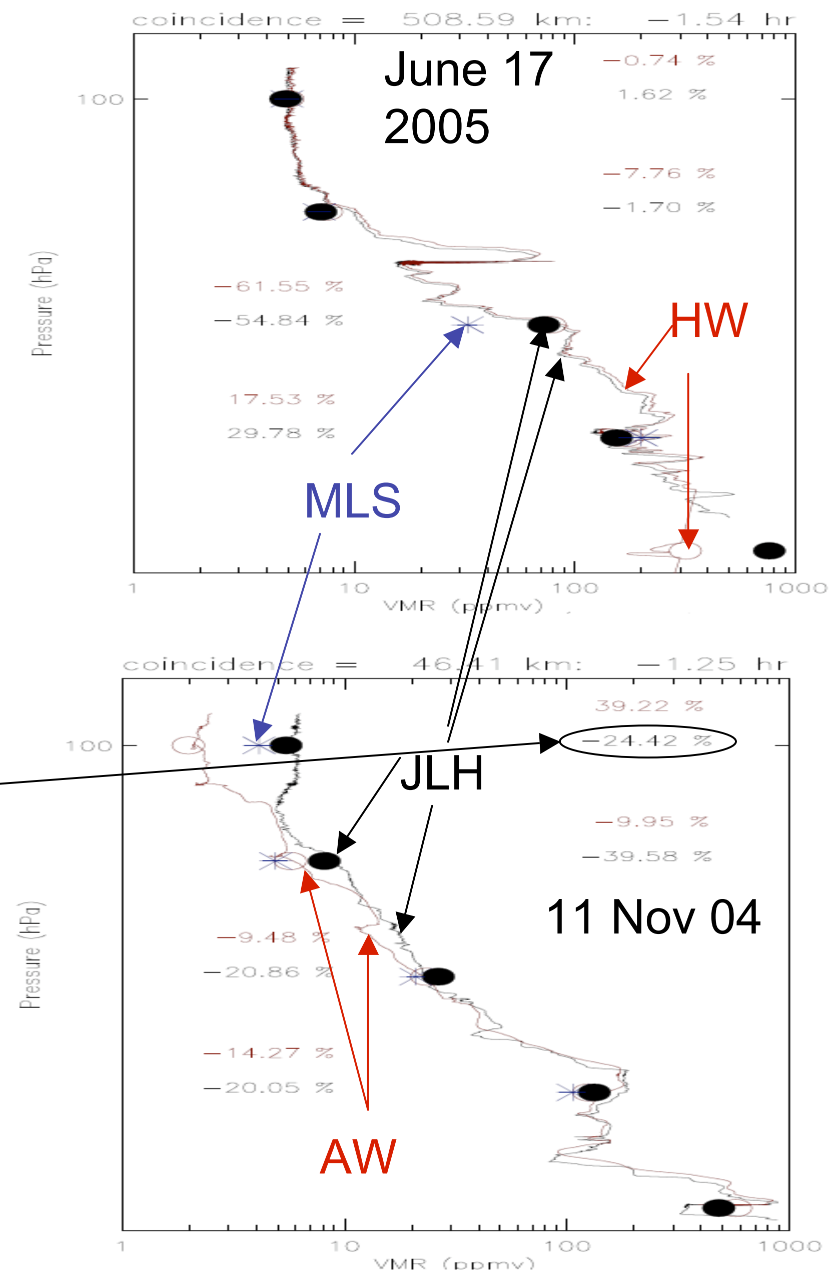
E. Weinstock


AVE-WIIF 20050703
AVE-WIIF 20050705
AVE-WIIF 20050707
pressure (mbar)
water vapor (ppmv)
latitude
(HVD+JLH)/2; lon>-93.6
MLS (29.7,-91.8)
MLS (31.1,-91.4)
MLS (32.6,-91.0)
MLS (34.1,-90.6)

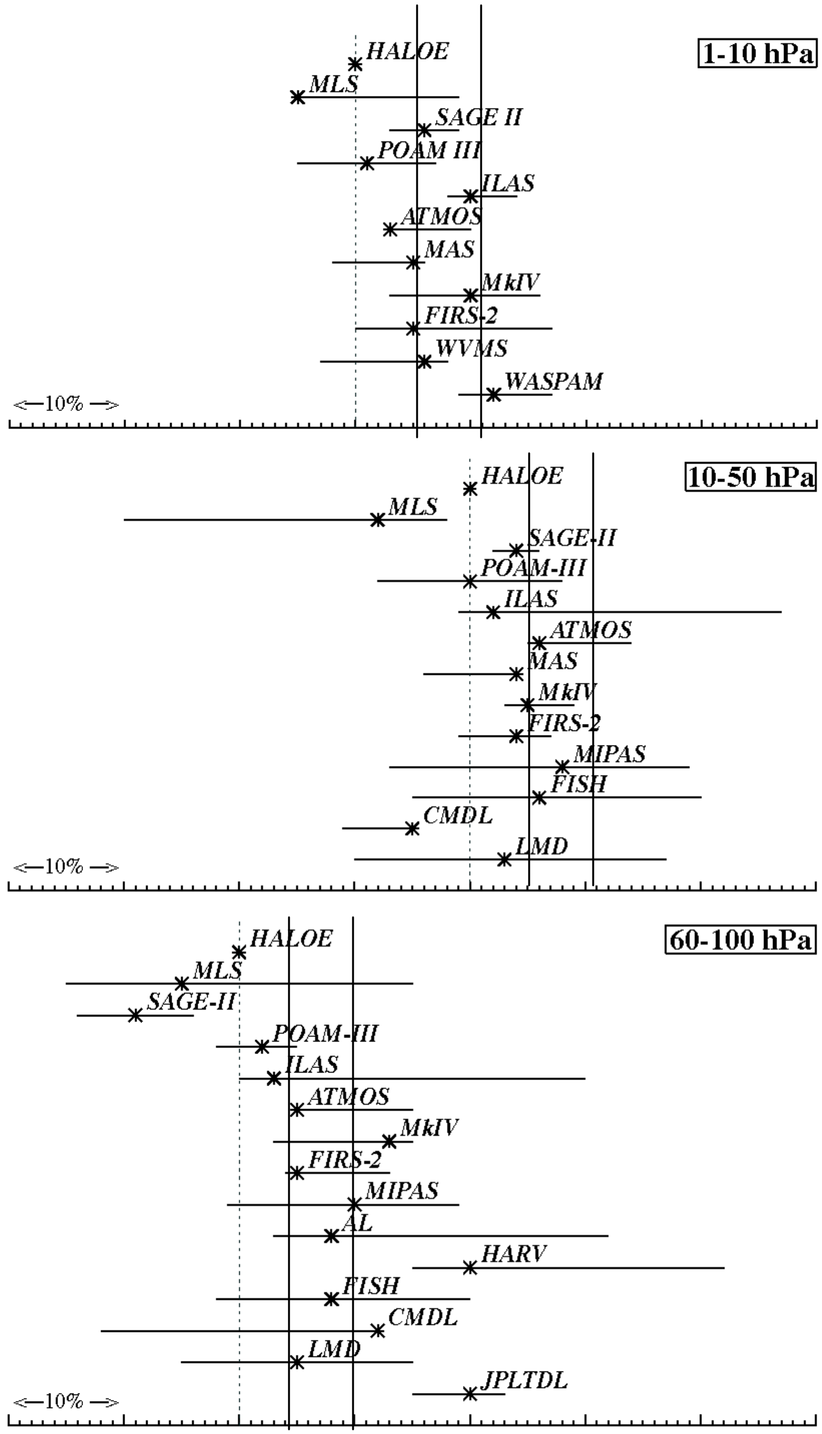
E. Weinstock

AVE profiles

- Decided to look at take-off and landing data.
  - Allows us to apply smoothing correction
  - Poorer coincidence
- JLH and HW track very well.
- JLH and Frostpoint(AW) have large differences especially near the tropopause.
- During level flight this is -31%
  - Applying vertical smoothing reduces the bias to -24%.
- Profile comparisons indicate that 1/3 of the bias seen in level flight is due to neglecting vertical smoothing.



B. Read



SPARC stratospheric comparisons (WAVAS 2000)

Based on comparisons presented, Aura MLS should lie between the black lines.

TES measurements are below 100 mb, and appear to average 10-30% higher than MLS.

Discussion topics, both during the session and afterwards….

1) How do we best validate to continue long term monitoring in the stratosphere and mesosphere?

2) What else is needed for validation?

3) What are the advantages/disadvantages for MLS producing a product with increased vertical resolution in the upper troposphere?

Additional validation needs

In situ and satellite comparisons are complicated by vertical resolution differences….really need extensive vertical profiles.

In aircraft campaigns, stacked flights may be more useful than level legs.

TES would like sonde data in conjunction with ground based measurements of total column, so sondes can be scaled (ie ARM sites, and coincident times)

Also, both TES and MLS may want to think about the differences shown between sondes and the research quality chilled mirror measurements, and determine ways of correcting the operational sonde data to improve accuracy of the most abundant correlative measurements.